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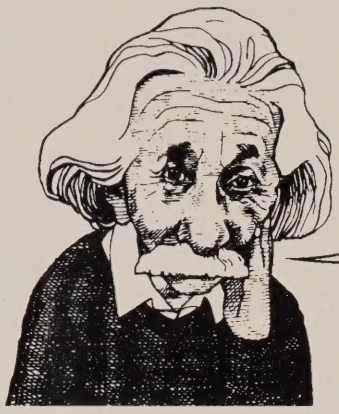

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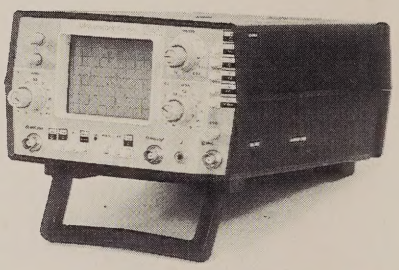

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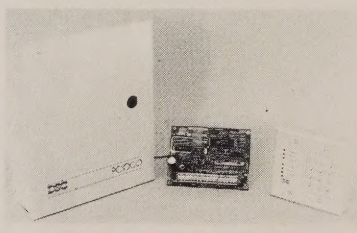

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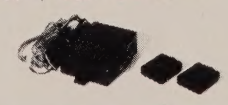

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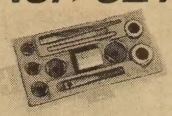

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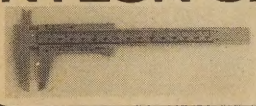

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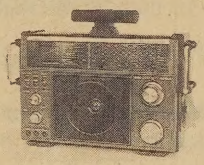

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VOLUME 4
NUMBER 8

SILICON CHIP®

August 1991

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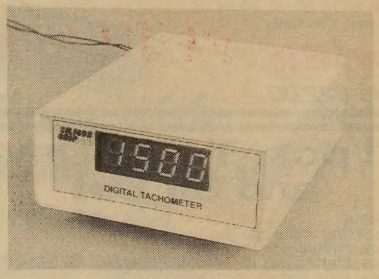

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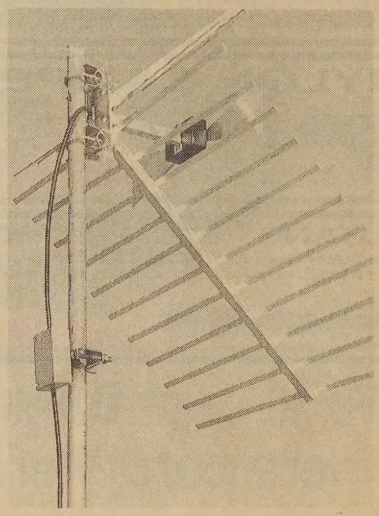
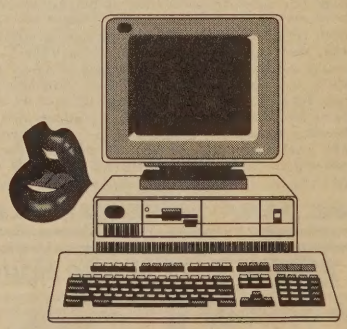


HAVING TROUBLE with your TV or FM reception. If so, add this booster unit to your antenna mast & clean up those noisy pictures. It uses a commercial power supply to make construction really easy. See page 24.



EXPLORE THE WORLD of digitized speech with our new low-cost PC voice recorder. It can record messages up to 20 seconds long, store them on hard or floppy disc, & then replay them when requested - see page 38.

PUBLISHER'S LETTER

Expanding career opportunities in electronics

Are you contemplating a career in electronics? Perhaps you are in your final years of high school and are wondering whether there are many opportunities for people skilled in electronics. As you research this field, you will find much conflicting information and often the government bodies responsible for providing careers information do not know just how diverse the field is.

Part of the difficulty is that many career paths involving electronics skills are not clearly defined. For example, consider the building industry, a field which most people would not regard as being electronics based. But every large building involves a big investment in electronic equipment, most of which is manufactured in this country. There is equipment for air-conditioning and ventilation, building security, fire and evacuation, electricity demand control and emergency stand-by power.

All this equipment is usually built and installed by separate companies but needs to be linked together for correct operation. For example, the air-conditioning and ventilation equipment will be linked to the fire and evacuation equipment so that in the case of fire, all the stairwells and office areas are maintained at the correct pressures so that the fire does not spread but people can safely escape. The air-conditioning will also be linked to the electricity demand monitoring equipment so that parts of it can be shed at peak load times, thereby keeping electricity tariffs to a minimum. Naturally, all this equipment is computer controlled and can be monitored remotely for correct performance.

When you consider the number of high-rise buildings throughout Australia, the total investment in such equipment must be truly enormous. Consider that all this equipment will require considerable maintenance in the future and that older buildings will need to be continually upgraded to make them more energy efficient.

The building industry is just one field where there are considerable opportunities for people skilled in electronics. You don't have to look far to find many more. A few more examples: automobile service, office equipment and medical electronics.

So while electronics manufacture in this country may have contracted in the last few years (and I am doubtful whether this is really true), the opportunities for people with electronics skills are continuing to grow at an ever increasing rate.

Leo Simpson

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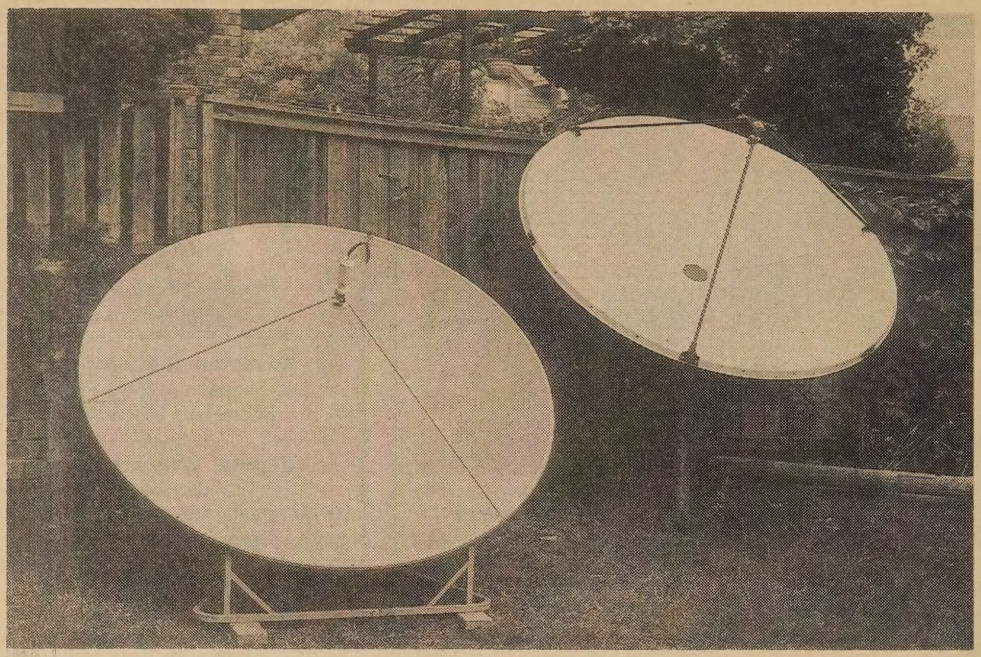

The $1000 satellite TV ground station is based on a 1.8-metre pressed steel dish as shown in the foreground of this photo. Unlike other dishes which use a steel mounting pole cemented into the ground, this unit uses a simple but effective "stand". The author's older 1.8-metre segmented dish is in the background.

Tuning in to satellite TV, Pt.3

This Ku-band ground station can receive TV pictures from Aussat for less than $1000. In this article, we take a look at the equipment and describe how it's set up to tune into Aussat 1.

By GARRY CRATT

Satellite enthusiasts will no doubt be impressed with the price tag of this satellite ground station. Imported by Av-Comm Pty Ltd, the system comprises a 1.8-metre pressed steel dish, a magnetic polariser and feedhorn, a low noise block converter (LNB), a 99-channel remote controlled receiver, and the cable to connect the components at the dish "head" to the receiver.

Installing the system is no more difficult than plugging in the components of a typical hifi system. The assembly of the dish is uncomplicated and the complete receiving station can be assembled in about 30 minutes, despite the fact that the only instructions are two dish assembly diagrams printed on the outside of the shipping carton.

The dish comes packed in a single heavy duty carton and weighs about 50kg. Unlike other dishes which use a steel mounting pole cemented into the ground or bolted to the top of a building, this unit uses a simple but effective "stand". This allows the dish to be used on balconies or in courtyards, where the installation of a 2-metre length of 100mm steel pipe would be impractical.

It's also means that you don't have to worry about cementing a steel pipe into the ground.

Siting the dish

The siting of the dish is most important. Under no circumstances must the "view" that the dish has towards the satellite be obstructed by nearby buildings or trees. Any obstruction will prevent reception.

Naturally, the dish must be adjusted for correct elevation and azimuth and

this is all part of the installation procedure. For example, the Aussat 1 pointing co-ordinates provided by the supplier for our location were: elevation 50.07°, azimuth 8.89°.

The elevation is easily set using a timber batten, a plastic protractor and a plumb bob (eg, a nut or bolt tied to a piece of cotton). By affixing the cotton to the centre of the protractor (either using glue or by drilling a small hole and then tying the cotton at that point) and holding the protractor against the batten, the angle formed with reference to the horizontal will be equal to the angle of elevation. Fig.1 shows the details.

The azimuth can be set using a magnetic compass and this procedure will be described later in this article. Of course, the compass and protractor method are only used to determine the initial pointing directions. We'll describe how to precisely adjust the dish for best reception later on.

You should also consider the expected reaction from neighbours when this 1.8-metre dish appears in your backyard. Even though the dish is powder coated a pleasant neutral grey colour, try to site the dish to minimise the impact on your neighbours. Where possible, the dish should be mounted so that it is out of sight (eg, behind a fence, a screen or bushes), whilst still maintaining a clear view of the satellite for good reception.

The mounting stand

Before installing the dish, you need to have a level mounting surface to accept the stand. This can easily be checked by using a spirit level and then packing the site with bricks or timber blocks to ensure a level mounting surface. Due to the unorthodox, but highly adaptable mounting system used, some explanation regarding assembly is appropriate.

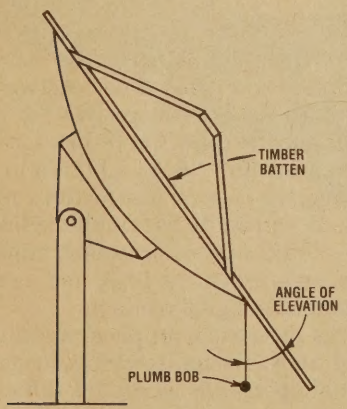

Fig.1: the angle of elevation can be set by using a protractor to measure the angle formed between a plumb bob & a wooden batten fixed across the face of the dish.

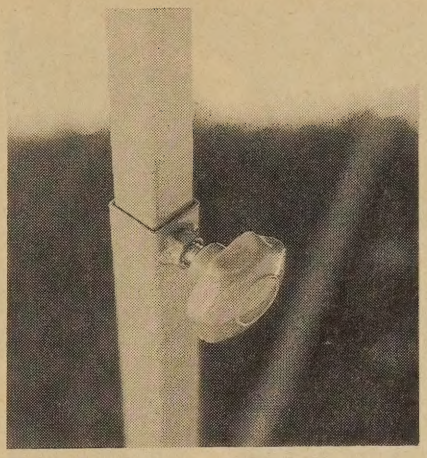

Fig.2: the elevation of the dish is adjusted by sliding a square section of steel tubing hinged to the apex of the dish inside another square section affixed to the base of the stand. This heavy duty thumbscrew then clamps the two sections together.

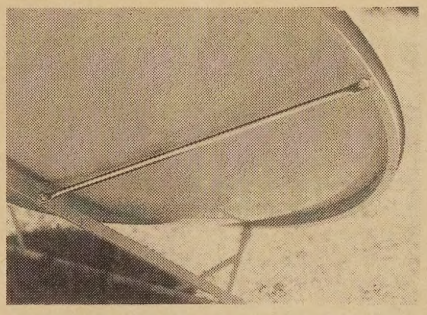

Fig.3: after the dish is removed from the carton, you have to remove two steel locking tubes like the one shown here, so that the dish can pivot on the hinges at the front of the stand.

In this design, the elevation of the dish is adjusted by sliding a square section of steel tubing hinged to the apex of the dish inside another square section of tubing affixed to the base of the stand. When the dish is elevated to the correct angle, a heavy duty thumbscrew clamps both sections together - see Fig.2

After removal of the dish from the shipping carton, two steel tubes, used to lock the frame to the dish for protection, must be removed and discarded. Fig.3 shows the location of one of these steel tubes. Once this is done, the dish is free to pivot on the two hinges at the front of the stand. Next, an "L" shaped section of steel tubing, which is supplied taped together with the three feedhorn support arms to the mounting stand, must be released and fitted between the apex of the dish and the base of the mounting frame. Note: this L-shaped section contains the elevation adjustment thumbscrew - see Figs.4(a) and 4(b).

The dish can now be tilted to a suitable angle (say 45°) and locked into position, allowing easy access to the mounting points for the three feedhorn support arms. These arms must be attached under three of the

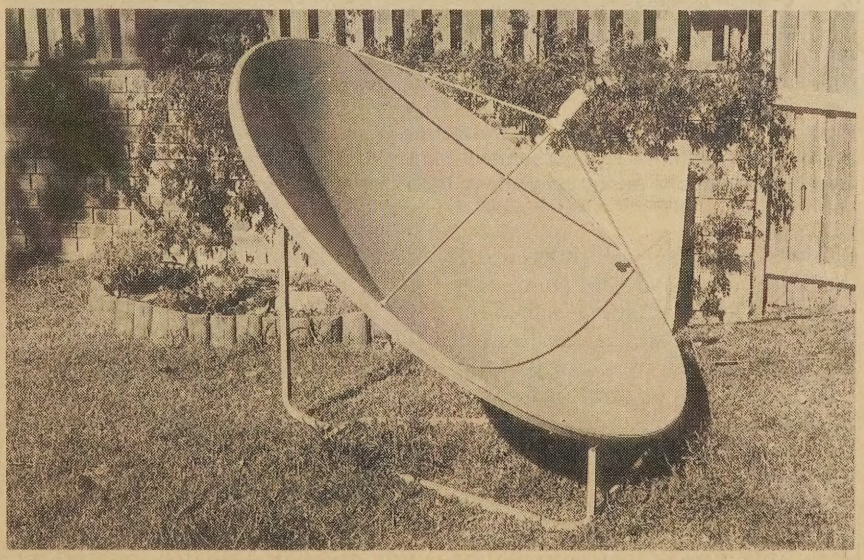

Fig.4(a): this view shows the fully assembled 1.8-metre dish. Note the L-shaped section at the rear. This contains the elevation adjustment thumbscrew.

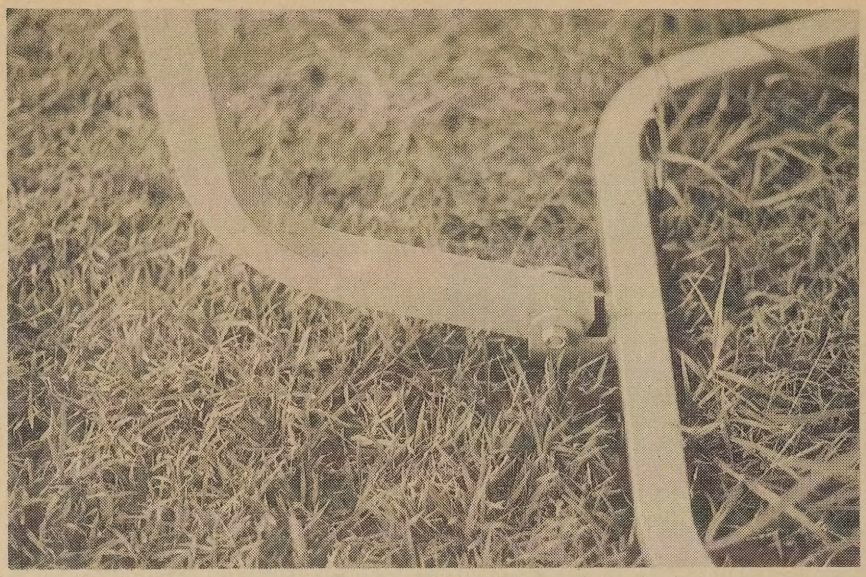

Fig.4(b): the L-shaped section is attached to the base of the stand via a hinged joint. This allows the L-shaped section to move as the dish is tilted to achieve the correct elevation.

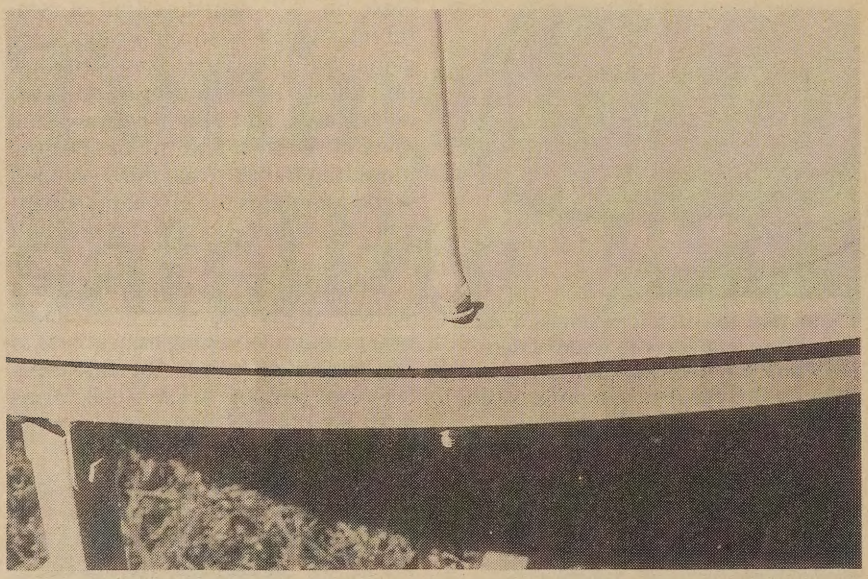

Fig.5: the three support arms for the feedhorn are bolted to three of six bolts around the circumference of the dish. Mount the arms at intervals of 120°, then attach the feedhorn mounting plate to the arms at the centre of the dish.

six bolts around the circumference of the dish and spaced 120° apart. This is easily done by undoing each of the three bolts and passing the head of each bolt through the corresponding hole on each support arm. Fig.5 shows the details.

After affixing all three arms, which may droop slightly at this stage of partial assembly, the feedhorn mounting plate must be attached to the three arms. This plate is a galvanised piece of steel with three recessed locating tabs at 120° intervals, each having the same shape as the ends of the support arms. The arms are now secured using the galvanised bolts and nuts supplied. In addition, there is a galvanised clamp which holds the throat of the feedhorn in position, as shown in Fig.7.

Feedhorn assembly

Prior to mounting the feedhorn in this clamp, the LNB (low noise block), feedhorn and magnetic polariser must be fitted together, to form one assembly. The feedhorn and polariser are supplied together in a single box, together with the necessary screws, so these two items should be assembled first. The LNB, which is supplied with a rubber gasket, is then secured by four stainless steel screws to the feedhorn/polariser assembly.

Because the aperture at the mouth of the LNB is rectangular, it is easy to align this correctly with the corresponding aperture of the polariser body. Fig.6 shows the complete LNB/polariser/feedhorn assembly while Fig.7 shows the assembly after it has been clamped in position.

At this stage, some consideration should be given to the routing of the cable from the LNB to the receiver. Among other things, this cable includes a low-loss double-shielded 75-ohm coaxial section which is used to carry a DC supply voltage from the receiver to the LNB and to carry the converted block of frequencies (from 12.25-12.75GHz) to the receiver. In addition, the cable has three separately insulated conductors: polarity, ground and signal strength (normally used for remote dish adjustment).

The cable should be routed so that it can not be tripped over, run over by the lawn mower, or subjected to other stress. If buried underground, the cable should be run through plastic conduit. This offers good protection and in the event of a malfunction, allows the faulty cable to be pulled through and replaced. The cable is terminated with "F" connectors and is small enough to be run through floorboards quite discreetly!

The receiver

At the other end of the cable, mounted indoors, is the receiver. It supplies the DC voltage (18V) to the LNB and decodes the IF block converted by the LNB. In addition to IF tuning, the receiver also features variable IF and audio bandwidth, adjustable audio subcarrier tuning, adjustable polarity for the LNB, and a programmable digital readout.

The receiver is supplied pre-tuned to all 15 Aussat transponders, to make initial operations easier. It's difficult enough to adjust both dish elevation and azimuth at once, without having to also tune the receiver for an active transponder. Once the dish is aligned and the system optimised, the receiver

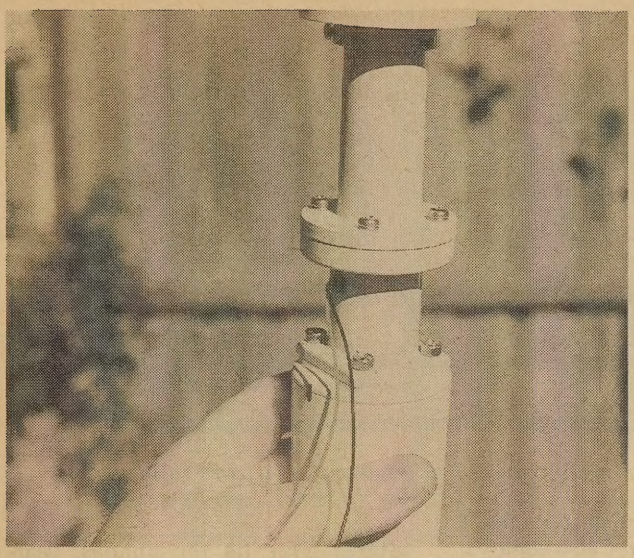

Fig.6: this close-up view shows the complete LNB/ polariser/feedhorn assembly, prior to installation on the mounting plate. The two leads shown emerging from the polariser are run to the receiver via the coaxial cable.

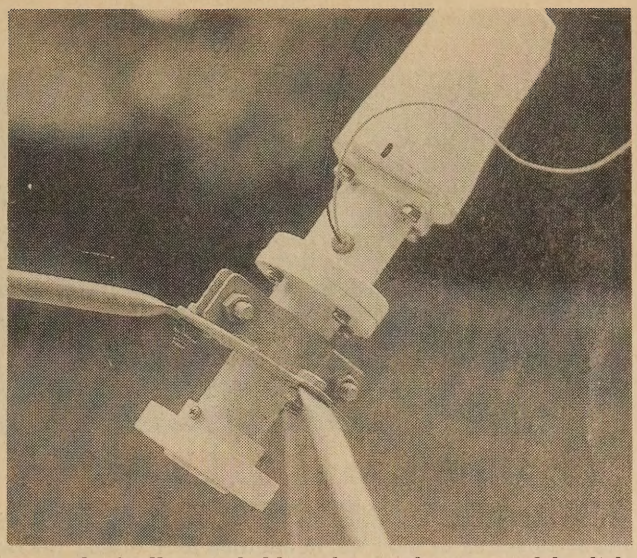

Fig.7: the feedhorn is held in place at the centre of the dish by a galvanised clamp attached to the feedhorn mounting plate. Adjust the feedhorn position & orientation for optimum signal as described in the setting up procedure.

tuning can be trimmed up. As all the receiver information is stored in an EEPROM, the units can be shipped around the country pre-programmed, without fear that a memory back up battery will go flat in transit.

The receiver features video and audio outputs, and a modulated RF output (channel 3/4).

Hence there are a number of methods of connecting the unit to a television set. The modulator output can be fed directly to the TV set and this is satisfactory if the set is being used solely for satellite TV use. If it is also used to watch terrestrial television, a switch should be installed in the antenna input lead. These items are commonly sold as "TV game switches" for less than $10 in most electronics stores.

Alternatively, the audio and composite video outputs could be fed to a VCR, and thence to the television receiver, or to a video monitor and separate audio amplifier. Of course, the audio can be connected to the AUX input of any hifi system, although the inputs to the amplifier must be tied together so that both audio channels are driven.

Tandy stores carry a suitable adaptor, which splits a single RCA female to twin RCA male connectors. The ultimate distribution method is to purchase a "video sender", which is a small, low-powered TV transmitter operating on a UHF TV channel. These units have a range of around 15 metres or so and enable satellite TV signals to be viewed on any suitable UHF-equipped TV set in the house. These units are also available from Tandy for around $100.

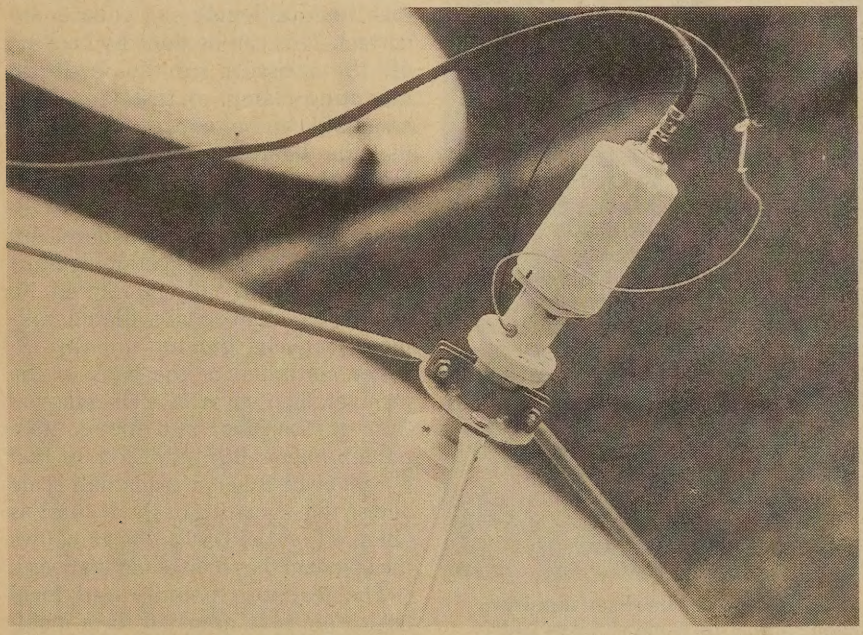

Fig.8: the low noise block (LNB) is connected to the receiver via low-loss 75Ω coaxial cable. Route the cable so that it is well out of the way or, better still, bury it in plastic conduit.

Final adjustments

Once the dish has been positioned as closely as possible to the specified azimuth and elevation settings, the cable should be connected to the receiver. For initial dish set up, nothing beats having the receiver and the TV set at the dish. This can normally be achieved by using a long 240 volt extension cord to power the equipment at the dish site. Remote indicators such as receiver audio and signal strength metering are impractical at such an early stage of the installation.

We initially set the receiver to trans-

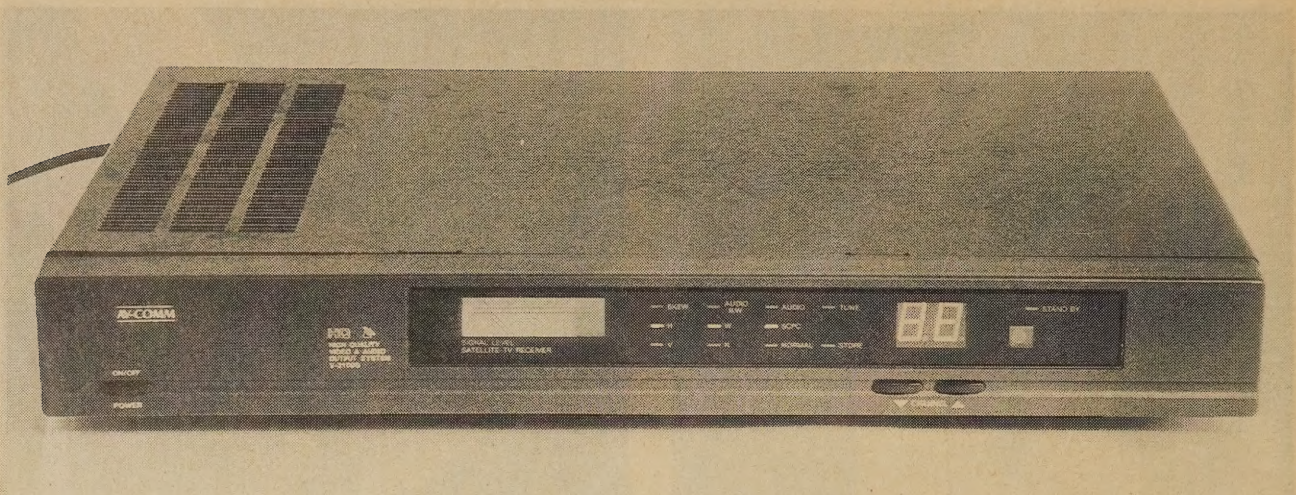

Fig.10: the receiver supplies the DC voltage (18V) to the LNB and decodes the IF block converted by the LNB. In addition to IF tuning, the receiver also features variable IF and audio bandwidth, adjustable audio subcarrier tuning, adjustable polarity for the LNB, and a programmable digital readout. The receiver is supplied pre-tuned to all 15 Aussat transponders & features video & audio outputs, plus a modulated RF output.

ponder 7 which is a strong B-MAC signal. A good indication that the system is working is to connect the LNB to the receiver and watch the impulse noise increase. Once this is verified, the dish can be aligned. Because the elevation has been set as described previously and because the receiver is pretuned to a known active transponder, the azimuth of the dish can now be set.

To do this using a magnetic compass involves taking the magnetic variation at the location of the Earth station into account. In our case, the azimuth for Aussat 1 was given as 8.89° but to compensate for the magnetic variation for Sydney, we had to subtract 11.5° (ie, the compass bearing was 357.39°).

All this sounds very complicated. In reality, all we had to do was take a rough reading in the general direction of the satellite and then gently rotate the dish until a picture was received. However, knowing the approximate compass reading certainly helps. When some kind of picture is visible, a series of "fine tuning" adjustments must be made.

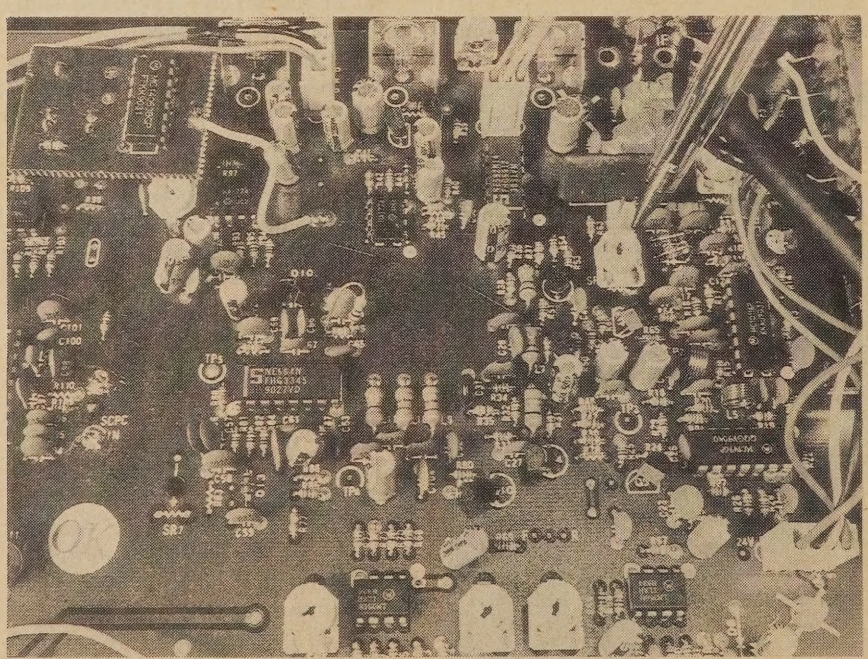

Fig.11: view inside the receiver. When a watchable picture has been obtained, trimpot RV6 (at the end of the pen) is adjusted so that the S-meter reads half-scale as described in the text. After that, the feedhorn polarity & focal length are carefully adjusted for maximum reading on a digital voltmeter connected between the receiver's S-meter terminal (on the rear panel) & ground.

Feedhorn adjustment

Apart from the elevation and azimuth which can both be adjusted for best reception, the position of the feedhorn must also be adjusted so that the focal length and polarity are correct. This can be done by backing off the pressure on the feedhorn mounting clamp so that the entire assembly can be rotated, and also so that the distance from the dish surface to the mouth of the feedhorn can be adjusted.

Once the picture and sound are watchable, further adjustments must be more scientifically monitored. To do this, we connected a digital voltmeter between ground and the "S-meter" terminal at the back of the receiver. The cover is then removed from the receiver and meter drive potentiometer RV6 adjusted so that the receiver S-meter reads half scale and so that a reading of about 70mV is obtained on the DMM. Fig.11 shows the layout of the receiver circuit board.

The feedhorn polarity and focal length are now adjusted for a maximum reading on the DMM. Often, this exercise must be repeated several times for optimum performance.

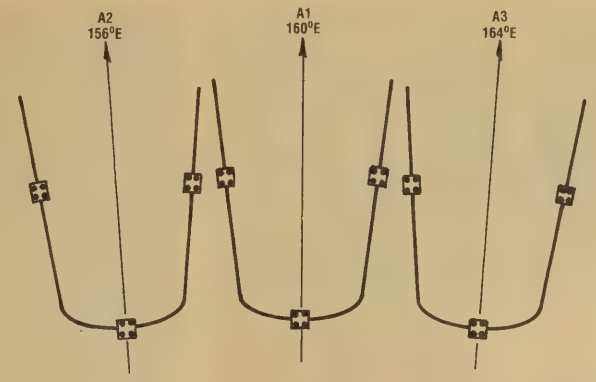

Fig.12: the dish can easily be moved to view each of the three Aussats by cementing three sets of galvanised bolts into the ground. Aussat 1 is at 160°E longitude, Aussat 2 at 156E° & Aussat 3 at 164E°.

Note that these latter adjustments may not result in any visible improvement to the received picture. This is because the satellite uses FM and once the receiver is in limiting, no noticeable improvement can be made to the received signal. However, by making these fine adjustments to squeeze the maximum performance from the dish, we are building up a performance margin which will compensate for rain attenuation, or a reduction in satellite transmit power.

Securing the dish

Once the maximum performance level has been achieved, the dish can be secured using the galvanised "U" brackets provided. However, if more than one satellite is to be received, the dish cannot be locked down permanently. On our system, we used heavy duty steel tent pegs obtained from the local disposals store to anchor the dish. Of course, a more permanent method would be to cement galvanised bolts into the ground in the appropriate locations, so that the dish could be moved from one set of mounting bolts to another for different satellites. Fig.12 shows how this can be achieved.

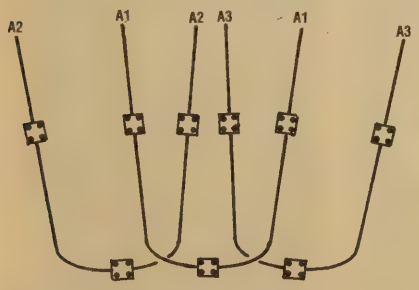

Fig.13: if space is a problem, the mounting locations for the dish can be overlapped. Don't forget to subtract the local magnetic variation when taking compass bearings.

Once successful reception has been achieved, most enthusiasts will want to explore the potential of their satellite receiving system. Besides television services, Aussat also carries a number of SCPC (single channel per carrier) radio programs. These can be found by connecting a scanner, capable of reception in the 950MHz to 1450MHz band. Experience has shown that most of these radio channels are horizontally polarised and are located around the 1200MHz area, using wideband FM as the mode of transmission.

It would be improper to list such frequencies here but any scanner fitted with a search function and capable of covering the appropriate frequency range will uncover these transmissions. To couple the LNB feed to the antenna input of a scanner, a splitter without DC feed capacity must be used. If the correct splitter is not used, the DC supply voltage from the receiver to the LNB will damage the scanner. Suitable splitters are available from most satellite hardware suppliers.

Finally, a note of caution. While there is no harm in viewing unencoded programming from Aussat to technically improve reception equipment, or out of interest in international affairs, or because of curiosity as to how TV networks operate, enthusiasts should be reminded that program material is protected by copyright laws and that some program material may be proprietary.

Also, the transmissions described in this and previous articles are not designed to be received by parties other than those who have paid the appropriate fee to do so, such as the transponder lessee, etc. This means that enthusiasts are in a privileged position to be able to receive such transmissions without cost. Any use of material broadcast through Aussat for commercial gain would therefore be absolutely illegal. **SC**

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Equipment Availability

Footnote: the satellite receiving system described in this article is available from AV-Comm Pty Ltd, phone (02) 949 7417 (see advertisement this issue). Similar satellite TV equipment is also available from Videosat Pty Ltd, 83 Alexandria Pde, Wahroonga 2076. Phone (02) 489 5474.

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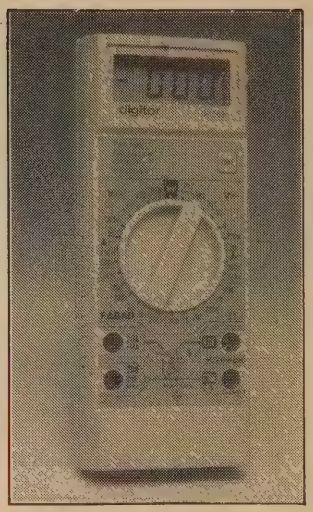

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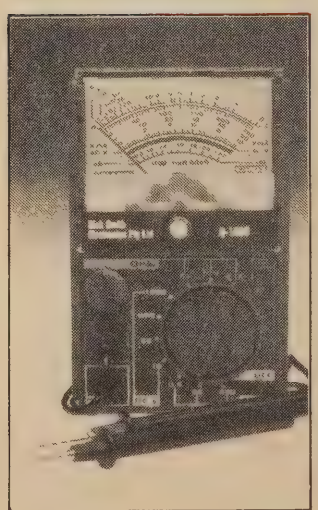

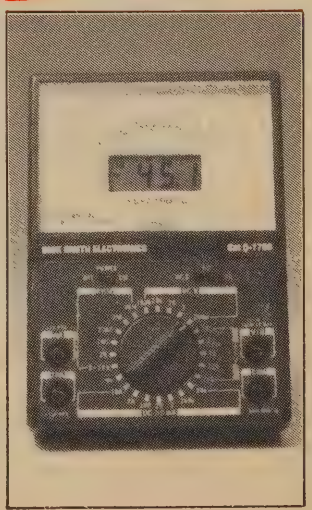

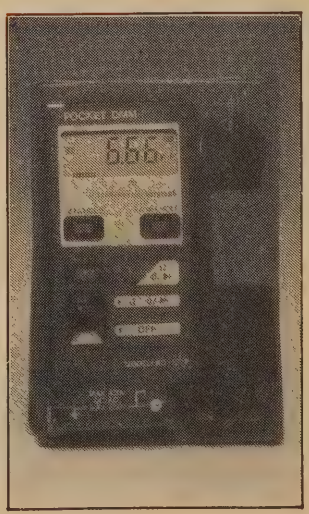

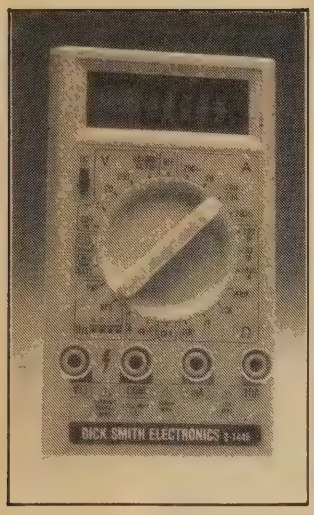

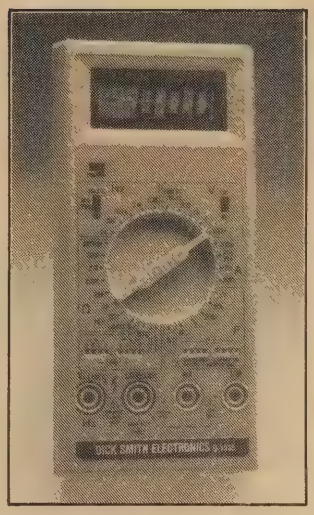
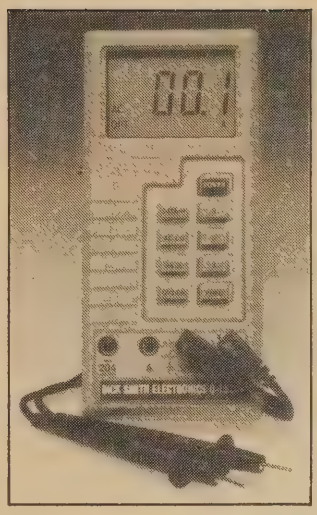
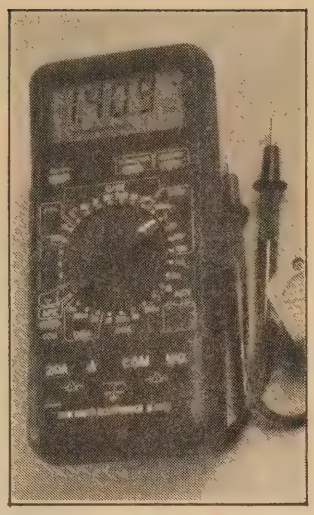

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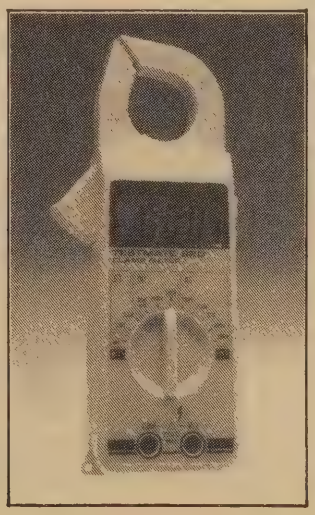

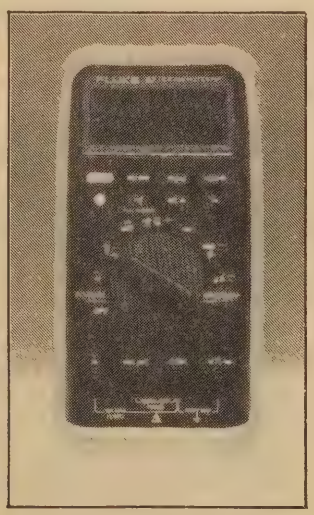

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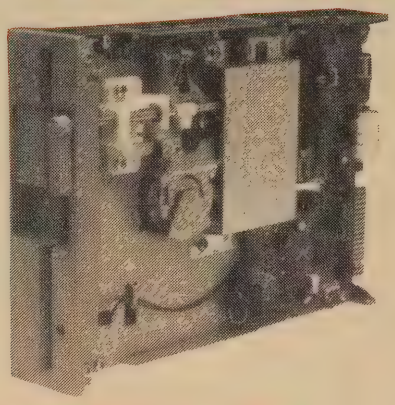

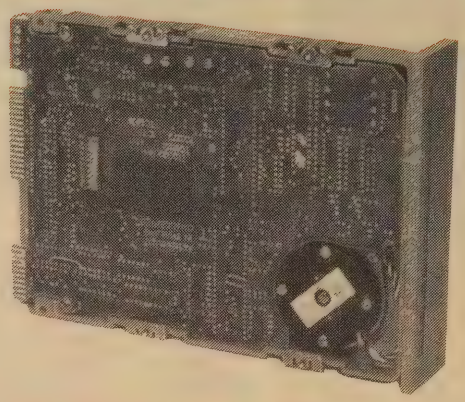

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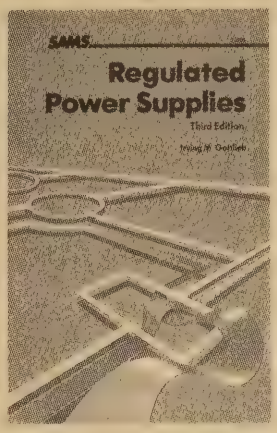
Reference on power supplies

Regulated Power Supplies by Irving M. Gottlieb. Published 1981, 3rd edition 1987 by Howard W. Sams & Co., Indianapolis Indiana, USA. Soft covers, 216 x 139mm, 420 pages. ISBN 0-6722-1808-9. Price $34.95.



This is one of the most thorough books on regulated power supplies around at the moment and definitely worth having on the shelf. It is well written and goes into good detail about the problems faced when designing a low-noise supply.

There are seven chapters in total. Chapter 1 talks about the need for well regulated supplies and their uses. Chapter 2 discusses basic concepts such as current and voltage regulation, as well temperature coefficients, stability and protection.

Chapter 3 delves into the dynamic characteristics of power supplies, such as output impedance, as well as the problems of interference and noise. Chapter 4 describes some of the techniques used, including switching regulators, pulse width modulation and digitally controlled power supplies.

Chapter 5 discusses the various components employed, including 3-terminal regulators, FETs, inductors, chokes and transformers.

Chapter 6 talks about linear regulated supplies using LM317s etc, as well as providing some circuits which would be good places to start for further design. Finally, chapter 7 talks about switching regulators using IC technology.

Overall, this is a worthwhile book, loaded with diagrams, tables and figures and at $34.95 is good value. Our copy came from Jaycar Electronics (Cat.BS-0526). (D.Y.)

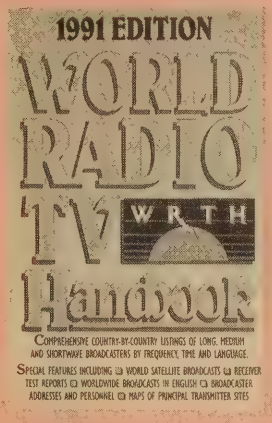
1991 Memory Data Book

Electronics Designs Inc. has issued the 1991 edition of its comprehensive data book of memory products. The 380 page book contains complete data on all EDI standard memory products, including its greatly expanded line of SRAM modules for commercial applications, and a sneak preview of products to be introduced in the near future.

EDI's Memory Data Book 1991 is available from their Australian representative, KC Electronics Pty Ltd; phone (03) 467 4666. **SC**

World Radio & TV Handbook

World Radio TV Handbook - edited by Andrew G. Sennitt. 45th edition published 1991 by Billboard Limited, London. Soft covers, 230 x 146mm, 576 pages. ISBN 0 8230 7792 6.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If you want to find out the TV and radio standards used in Yugoslavia or Peru, where do you look? There's only one reference which is likely to have the answers and that is this book. This is the 45th edition and its format is exactly the same as past editions except that it is a little larger. It contains a vast amount of information, being a comprehensive country by country listing of all the long, medium and shortwave broadcasters by frequency, time and language.

Other features are listings of world satellite broadcasts, broadcaster addresses and personnel, worldwide broadcasts in English, maps of principal transmitter sites, and finally reviews of communications receivers.

Our copy came from Dick Smith Electronics (Cat. B-2091). Their price is $35.95.

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While the following suggests a suitable procedure for "dead" receivers, many of its points are equally applicable to radios with weak reception.

It is not suggested that the procedure outlined should be used followed to the letter. No-one who smells a burnt-out power transformer would persist in making tests on an aerial coil for example, and would have enough sense to detour to the appropriate section.

(1). Examine the set for signs of overheated components such as power transformers and resistors, or charring of the rectifier or speaker sockets. Do not switch the set on for this check. Check that all valves are tight in their sockets, the grid clips are on, the speaker plug is making good contact, there are no leads broken away, and that the set is switched to "Broadcast" and not "Gram" or "Shortwave".

(2). Before turning on the set, check the condition of the power cord and plug. If the cord is damaged or stiff and brittle, or if the plug is cracked or chipped, replace the cord and/or plug. Replace with a 3-core cord where possible (except on AC/DC sets) and wire according to SAA rules.

Switch on the set, watching the rectifier valve to see if it arcs or has a heavy blue glow. If OK, proceed with section 3. If arcing is present, a short circuit is indicated, or maybe a heavy load. This may be a shorted or leaky filter capacitor or a short between the high side of the choke and chassis.

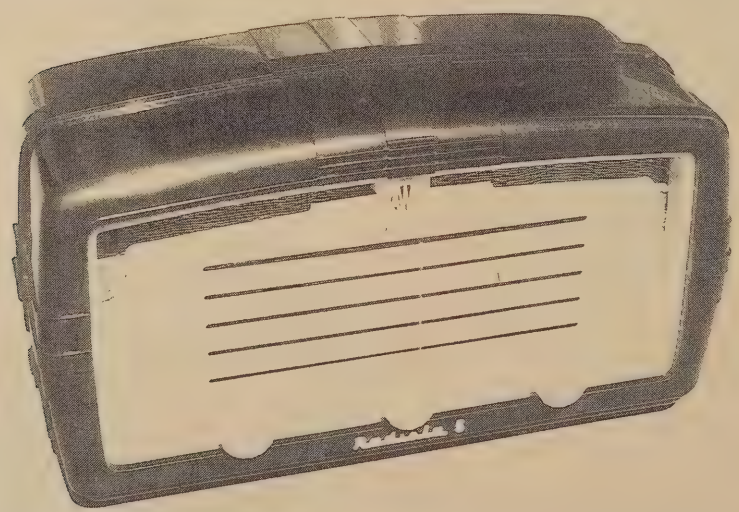
A heavy blue glow may indicate a leaky filter capacitor or some other leakage or short on the high tension line. Some rectifiers may become gassy with age and exhibit a blue glow.

Switch the set off in all cases and take a reading with an ohmmeter between the cathode (indirectly heated rectifier) or heater and the chassis. The reading should not be below 10kΩ. If it is, move the ohmmeter to the output side of the filter choke or dropping resistor to see if the reading is higher or lower. If higher, the short or leakage is on the rectifier side - if lower it is on the output side. Having found on which side the fault occurs, unsolder one component at a time on that side of the line until the ohmmeter reads 10kΩ or higher.

(3). Visually examine the screen of the output valve. With some types of valves, it may be necessary to make the observation by looking downward from above the valve. If the screen is not glowing, proceed with step (4). If it is glowing, it indicates that the screen is receiving voltage while the plate is not.

Most likely the speaker transformer has an open circuit primary winding. If the speaker transformer is mounted on the speaker, it is possible that there is a high resistance or open circuit at the speaker socket or on the wires to the speaker.

(4). Visually examine all valves to ascertain if their heaters are lit and feel the valves to see if they are warm. If OK, proceed with step 5. Where heaters are not glowing, take an ohmmeter reading between each valve heater pin and its socket contact in turn to ensure that the contact resistance is less than 0.1Ω. If the contacts are OK, check the valve heaters with



This old Radiola 5 is a popular receiver from the mid-1950s. Although not really a set to appeal to the vintage radio enthusiast, it was quite a reasonable receiver & you should have little difficulty in obtaining parts.

an ohmmeter after withdrawing the suspect valves from their sockets.

(5). Listen for hum in the loudspeaker. If it is present, proceed with step 6. If not, proceed with step 7.

(6). Turn up the volume control and touch a finger to the pick-up terminal (remove the shorting link if necessary) or to the grid cap of the audio valve (warning: don't do this with a transformerless set). A loud buzz or hum in the speaker indicates that the audio section is functional. If so, proceed to step 8; if not, go to step 7.

(7). Make a voltage check between the plate of the output stage and the chassis, ignoring the screen voltage. If no click is heard even though normal voltage is present, and if no hum is heard in the speaker (see step 5), switch off and check the voice coil winding and loudspeaker leads for shorts or an open circuit. Desolder one side of the voice coil winding for this test. If no voltage is present at the plate, check at the screen. If absent here also, check at the rectifier cathode and on either side of the choke and/or field coil.

Make a voltage reading between the grid of the output valve and the chassis. Any positive reading indicates a faulty coupling capacitor and it may also be necessary to replace the valve. For self-biased sets, check the bias on the output stage cathode. If absent, check the bias resistor for continuity and the cathode bypass capacitor for a short. Also, check any capacitors (if present) that connect between the output valve plate and chassis or plate and screen, and any capacitors that form part of any plate circuit tone control. If the audio fault persists proceed with step 9. If cleared, proceed with step 8.

(8). Check all plate, screen and bias voltages on valves prior to the detector stage. If OK, switch off the set and make resistance checks on all coils. If OK, proceed with step 9.

(9). If a valve tester is available, test the valves for emission and shorts. Temporarily replace doubtful ones, particularly the mixer, for faults ahead of the detector, and the detector for faults that exist from that stage on. If OK, proceed with step 10.

(10). Turn the volume control full on. Switch the set to the broadcast band and inject a signal from an RF signal generator at the correct intermediate frequency (IF) to the primary of the first IF transformer. If no sound is heard, the fault is after the first IF transformer. Go to step 13 for further checks. If OK, proceed with step 11.

(11). Inject a signal at broadcast frequency to the antenna terminal (note: turn the signal generator output well up to allow for mistuning). Use a high frequency (1200-1500kHz) to avoid misleading results if the variable capacitor plates are shorted. Tune the set to the approximate frequency. If no signal is present, go to step 12. If the signal is weak, check the aerial coil for shorts. It should not be open, as the resistance test in step 8 would have shown this fault.

(12). Connect a high resistance multimeter or VTVM (AC range) to the fixed plates of the oscillator gang. A reading of between 5 and 30 volts should be obtained. If not, check the oscillator grid leak, capacitor and oscillator plate voltage. When the oscillator stage is OK, go to step 13.

(13). Check the AVC and other bypass capacitors, then the plate, screen and bias resistors. Test the IF and other trimmers for short circuits. If OK proceed with step 14.

(14). Connect a meter or CRO to the voice coil winding and turn the signal generator off. There should be no reading or pattern (except a straight line). If there is, oscillation is occuring, causing possible grid blocking or overloading. Short the plate of each valve from the output stage back in succession with a capacitor to earth to localise the fault. If OK, inject in turn an AF signal at the pick-up terminals, an IF signal at the detector and each IF stage, and a broadcast signal at the aerial and RF stages, to locate the faulty stage. There will of course be no pattern or reading if the voice coil is shorted but this fault should have been cleared by check 7.

It is highly probable that most faults will have been located well before check 14.

Footnote: this article was contributed by Resurrection Radio, 51 Chapel St, Windsor, Victoria 3181. **SC**

WARNING

Dangerous voltages are present in valve radio sets. In particular, stay away from transformerless AC/DC sets unless you know exactly what you are doing.

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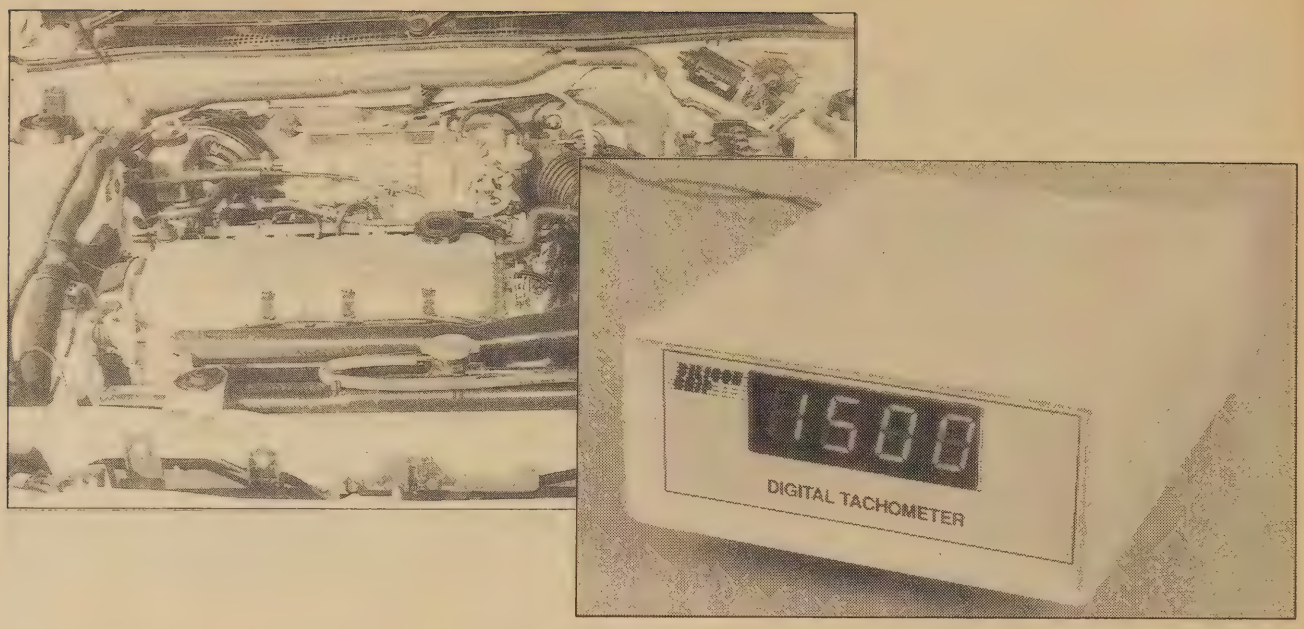


Build this LED digital tachometer

Have you ever wondered how many revs your car's engine is doing at 100km/h or at any speed for that matter? This digital tachometer will tell you. It works with all ignitions from Kettering to Hall Effect systems and with 4, 6 & 8-cylinder cars.

By DARREN YATES

Although many new cars feature a conventional analog rev counter, it's hardly what you would call an exciting use of technology! By contrast, this new tachometer features a bright 4-digit readout that indicates from 0-9900 RPM with a resolution of 100 RPM.

As can be seen from the photographs, the unit is housed in a neat little plastic case that can easily be attached to the dashboard of your car using Velcro strips. The unit is very easy to build and uses readily available parts. In fact, you will probably already have most of the parts in your junkbox.

Unlike many other tachometers, this unit will work with just about any car ignition system. We checked the prototype on a number of cars ranging from Commodores & Falcons with electronic ignition systems through to a beat-up old VW with a points-switched (Kettering) ignition. The unit worked perfectly in all cases, although the calibration control does have to be reset when switching between cars with different numbers of cylinders.

Only three connections are required to connect the unit to your car: one to the negative terminal of the coil and two for power (+12V and GND). The positive supply is derived from the ignition switch, so that the unit is switched on and off with the engine.

Basic principle

The tacho circuit basically works as a frequency counter but first we should consider what it is that we are counting.

In a 4-stroke design, the ignition coil produces two sparks per revolution for a 4-cylinder engine, three sparks per rev for a 6-cylinder engine, and eight sparks per rev for an 8-cylinder engine. So if we have a 4-cylinder engine operating at 1500 RPM, then the ignition coil must be delivering 3000 high voltage pulses per minute. This corresponds to a frequency of 3000÷ 60, or 50Hz.

This frequency of 50Hz also corresponds to 1000 RPM for a 6-cylinder

engine and 750 RPM for an 8-cylinder engine. Since the frequency goes up linearly with revs per minute, all we need to do is sample the pulses from the engine coil for the correct amount of time to give the correct display.

Because we decided on a maximum count of 9900 with a resolution of 100, we only needed a 2-digit counter. This 2-digit counter is used to drive the two most significant digits (MSDs) of the display, while the two least significant digits are permanently wired to show "0"s. This keeps the complexity and cost of the project to a minimum.

Engine irregularities

The other reason for using just a 2-digit counter is that a 3 or 4-digit design would be overkill because of engine irregularities. At any speed setting, an engine will typically vary its speed from moment to moment by as much as ±50 RPM and this means that the last two digits of a 4-digit display flicker continuously. This effect applies even to the latest cars with their electronic ignitions and fuel injection controlled by a microprocessor. They are certainly smoother than the older cars with carburettors and Kettering ignition but they vary nonetheless.

Therefore, it makes good sense to use a 2-digit counter with two extra digits as dummies, to make the display easily read, at a glance.

If we intend to fit this counter to a 4-cylinder car, we have to make a 50Hz input appear as 1500 RPM on the display. However, as we've just pointed out, we are only concerned with the two most significant digits which, in this case, must display "15". This is achieved simply by counting the 50Hz input for 0.3 seconds.

But what if you have a 6-cylinder car? Well, the two MSDs must read "10" for the same 50Hz input which means that we only have to count for 0.2 seconds. Similarly, for an 8-cylinder car, we have to count the 50Hz input for 0.15 seconds to get a display of "7" or "8", which is as close to 750 RPM as we can get.

Block diagram

Refer now to Fig.1 which shows a block diagram of the circuit. As shown, the input is taken from the negative side of the coil's primary winding (ie, from the points or main switching transistor). Each time the ignition coil switches, it generates a voltage spike of about 300V, followed by a ringing waveform of decreasing voltage due to the coil's self-resonance.

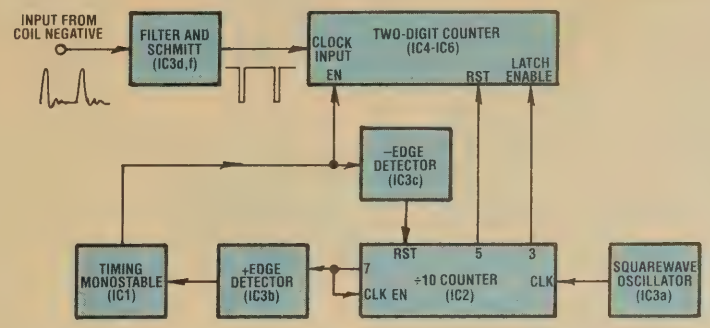
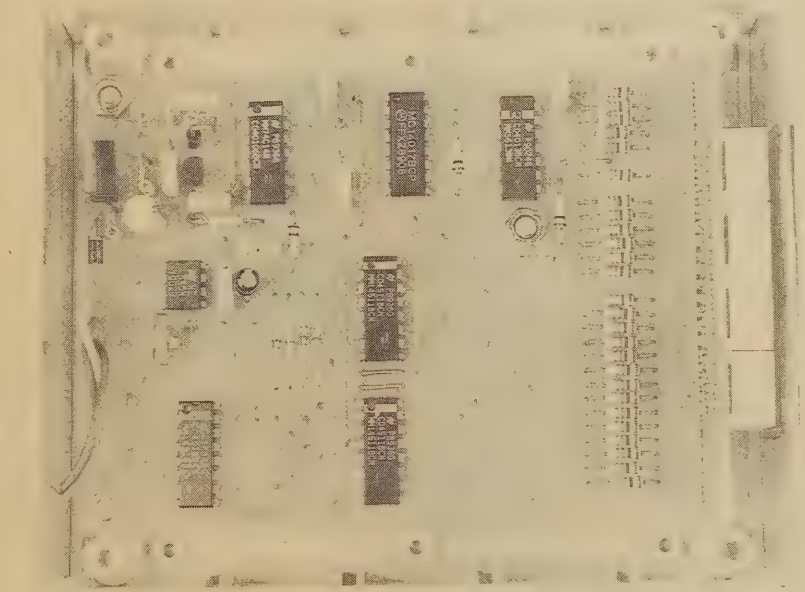


Fig.1: block diagram of the Digital Tachometer. The high voltage spikes produced at the negative terminal of the coil are applied to a Schmitt trigger/filter stage which produces clean square wave pulses. These pulses are then fed to a 2-digit counter which drives the two most significant digits. The remainder of the circuit produces the necessary timing signals for the counter - reset, clock enable & latch enable.

This input signal is filtered and fed to a Schmitt trigger stage (IC3d,f) which produces clean squarewave pulses corresponding to the high voltage spikes. These pulses are then fed into the clock input of the 2-digit counter (IC4, IC5, IC6; more about this later).

To produce a display that updates smoothly, we need to store and display the previous count while the counter is tallying up the new one. The rest of the circuit deals mainly with this task.

Going back to the block diagram, a squarewave oscillator (IC3a) continually feeds a divide-by-10 counter (IC2) with clock pulses. The CLOCK ENABLE line of this counter is "active low", which means that for the counter to advance, the line must go low. Because it is a divide-by-10 counter, each



All the parts for the Digital Tachometer are mounted on two PC boards. These two boards are soldered together at right angles & fit neatly inside a standard plastic case. A red perspex window sits in front of the LED displays.

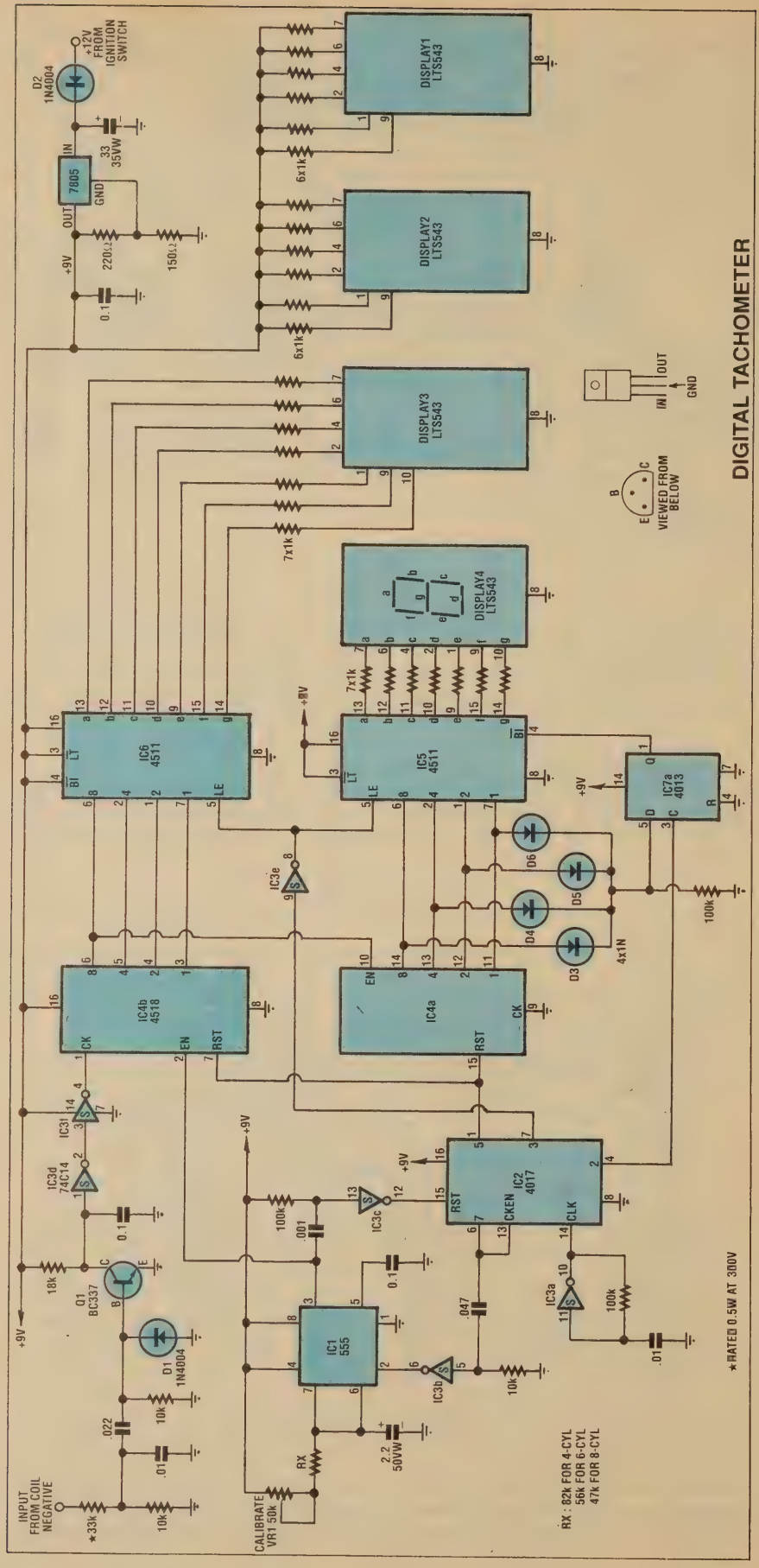


Fig.2 (left): all the circuit functions depicted in the block diagram (Fig.1) can be directly related to this main circuit diagram. Q1, IC3d & IC3f form the Schmitt trigger/filter stage & this drives a dual 4-bit BCD counter (IC4b & IC4a). These counters then drive 7-segment decoders IC6 & IC5 which in turn drive the two most significant digits. IC7a provides leading zero blanking, while IC1, IC2 & their associated Schmitt trigger inverters provide timing signals for the 2-digit counter.

successive output goes high in turn as the counter is clocked.

The 7th decoded output is fed into the CLOCK ENABLE line, so that when power is first applied, the CLOCK ENABLE is held low, thus allowing the counter to count. When output "3" subsequently goes high, it triggers the LATCH ENABLE of the 2-digit counter. This instructs the 2-digit counter to store and display the pulse count from the coil..

During this time, the squarewave oscillator continues to clock the divide-by-10 counter. When output "5" subsequently goes high two clock pulses later, it resets the 2-digit counter so that it is ready to count the next series of pulses on its clock input.

This counting period is initiated another two clock pulses later, when output "7" goes high and pulls the CLOCK ENABLE input high to stop the divide-by-10 counter. This high on output "7" also triggers a timing monostable (IC1) via a positive-edge detector (IC3b), which allows the 2-digit counter to count the incoming pulses for a specified period of time.

The timing monostable output goes high for 0.3s for a 4-cylinder engine, 0.2s for a 6-cylinder engine and 0.15s for a V8. This output is fed into the CLOCK ENABLE input of the 2-digit counter which now starts counting.

At the end of the specified interval, the output of the timing monostable goes low and the 2-digit counter is disabled. This low-going signal is also picked up by a negative-edge detector (IC3c) when then provides a short positive-going pulse at its output to reset the divide-by-10 counter.

This allows the divide-by-10 counter to again go through the above sequence of steps; ie, latching and dis-

playing the current count in the 2-digit counter, then resetting the 2-digit counter and allowing it to count the next timing interval.

Circuit details

Take a look now at the main circuit diagram - see Fig.2. It contains all the circuit elements shown in the block diagram (Fig.1).

The input pulses are taken from the negative-side of the primary winding of the coil and fed to a voltage divider consisting of 33kΩ and 10kΩ resistors. Because of the high voltages involved, the 33kΩ resistor must be rated at 0.5W and 300V. The signal is then AC-coupled into the base of transistor Q1 which acts as a switch.

Each time a high voltage spike is applied to the input, Q1 turns on and shorts a 0.1µF capacitor to ground. This in turn pulls the input of Schmitt trigger IC3d low and thus the output of IC3f (pin 4) also goes low.

Because the input spike to Q1 is very narrow, the transistor quickly turns off again. The 0.1µF capacitor across Q1 now charges via an 18kΩ resistor and, after a brief period, switches pin 4 of IC3f high again.

The RC time constant here is about 2ms, which is longer than the period for which hash (ie, ringing due to coil resonance) is present on the input signal. In practice, this means that the input circuit is disabled for about 2ms after the initial spike is detected to prevent false triggering.

The output of Schmitt trigger IC3f thus consists of a series of negative-going pulses, with each pulse corresponding to a plug-firing pulse from the coil. These pulses are now fed into the clock input (pin 1) of IC4b which is half of a 4518 dual 4-bit binary-coded-decimal (BCD) counter.

The most significant bit of IC4b is connected to the CLOCK ENABLE input (pin 10) of IC4a to produce a 2-digit BCD counter. The 4-bit outputs of each counter are then fed into separate 4511 7-segment decoder ICs (IC5 & IC6) which in turn drive the two most significant displays.

Leading zero blanking

To make the display more attractive, we have added leading zero blanking to the unit. This part of the circuit is quite simple and relies on the fact that if the leading digit is "0", then each of the four bits output from IC4a will be low. These outputs are fed into a 4-input diode OR gate (D3-D6), the output of which is fed to D-type flipflop IC7a.

IC7a acts as a memory cell or latch. When the DATA input of IC7a goes low, the Q output also goes low at the next clock pulse. This in turn pulls the BLANKING INPUT (pin 4) of IC5 low and so display 4 is turned off.

However, if the leading digit has any value from 1-9, the output of the diode OR gate will be high. Thus, the output of IC7a will also be high and so the blanking function will be disabled.

Timing circuit

IC1, IC2 and Schmitt trigger inverters IC3a, IC3b & IC3c make up the timing circuit (see also Fig.1).

Schmitt trigger IC3a is connected as a simple square wave oscillator which operates at about 450Hz. Its output at pin 10 drives the clock input (pin 14) of IC2 which is a 4017 divide-by-10 counter.

When power is first applied, IC2's "0" output is high and the remaining outputs are all low. The remaining outputs then go high (and low again) in sequence as the counter is clocked.

After two clock pulses, the "2" output at pin 4 goes high and clocks IC7a, which is the leading zero blanking latch. This ensures that if the most significant digit is zero, it will be blanked out for the whole timing cycle.

On the next clock pulse from IC3a, IC2's "3" output (pin 7) goes high. This high is inverted by IC3e and fed to the LATCH ENABLE (LE) pins of decoders IC5 and IC6. These ICs then latch the counts at the outputs of IC4a & IC4b and decode this binary data to drive the two leading 7-segment displays (display 3 & display 4).

With the count now latched and displayed, IC2's "5" output (pin 1) goes high two clock pulses later and resets counters IC4a & IC4b. These two counters are now ready to start counting a fresh sequence of pulses from the coil but this doesn't happen until the clock enable input (pin 2) of IC4b is pulled high. We'll see how this happens shortly.

In the meantime, IC2 continues to count up until output "7" (pin 6) goes high. When this happens, it pulls its own CLOCK ENABLE input (pin 13 high) and thus disables the clock input. As

PARTS LIST

1 plastic instrument case, Arista UB14 or DSE Cat. H-2503
1 PC board, code SC05108911, 112 x 84mm
1 PC board, code SC05108912, 84 x 38mm
1 front panel label, 115 x 40mm
3 6mm standoffs
1 piece red perspex, 55 x 20mm
1 50kΩ linear mini vertical trimpot

Semiconductors

1 NE555 timer IC (IC1)
1 4017 CMOS divide-by-10 counter (IC2)
1 74C14 CMOS hex Schmitt trigger inverter (IC3)
1 4518 CMOS dual BCD UP counter (IC4)
2 4511 CMOS 7-segment display drivers (IC5,IC6)
1 4013 CMOS dual D flipflop (IC7)
1 7805 +5V regulator
1 BC337 NPN transistor (Q1)
2 1N4004 power diodes (D1,D2)
4 1N914 signal diodes (D3-D6)
4 LTS543 common-cathode 7-segment displays

Capacitors

1 33µF 35VW electrolytic
1 2.2µF 50VW electrolytic
4 0.1µF 63VW 5mm-pitch metallised polyester
1 .047µF 63VW 5mm-pitch metallised polyester
1 .022µF 63VW 5mm-pitch metallised polyester
2 .01µF 63VW 5mm-pitch metallised polyester
1 .001µF 63VW 5mm-pitch metallised polyester

Resistors (0.25W, 5%)

3 100kΩ
1 82kΩ
1 56kΩ
1 47kΩ
1 33kΩ (0.5W, 300V)
1 18kΩ
3 10kΩ
26 1kΩ
1 220Ω
1 150Ω

Miscellaneous

Solder, insulated hookup wire, tinned copper wire, screws, nuts & washers.

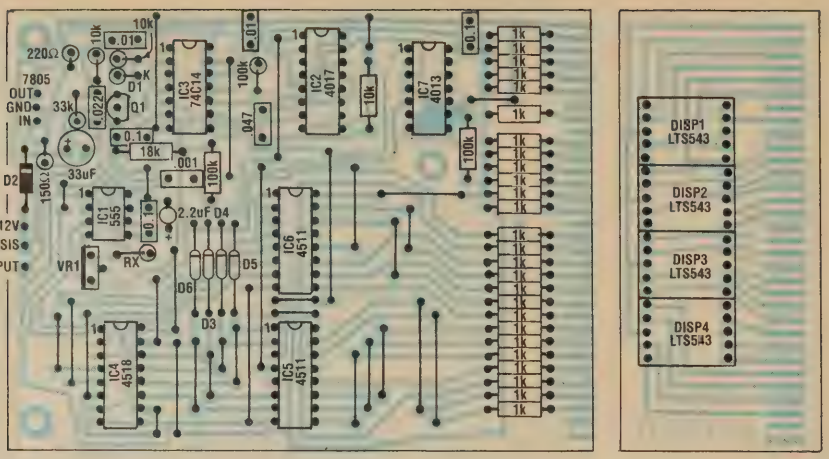


Fig.3: install the parts on the PC boards as shown here & pay particular attention to the orientation of the semiconductors & the LED displays. After assembly, the two PC boards are soldered together at right angles (see text).

a result, the "7" output stays high for a fixed period of time, until IC2 receives an external reset signal.

This external reset signal is supplied by 555 timer IC1 which also sets the count time. It works like this. When decoded output "7" goes high, it also triggers a positive edge detector consisting of Schmitt trigger IC3b, a 10kΩ resistor and a .047μF capacitor. IC3b thus momentarily switches its output low and this triggers IC1 which is connected as a monostable.

When the 555 is triggered, its output at pin 3 goes high for a short period of time, as determined by VR1, resistor Rx and a 2.2μF electrolytic capacitor. This high is fed to the CLOCK ENABLE input of IC4b which is now clocked by pulses from the coil. The counter is subsequently disabled when pin 3 of IC1 goes low at the end of the timing period, after which the 4-bit counts are latched by IC5 & IC6 as described previously.

Trimpot VR1 allows the monostable period to be adjusted so that the tacho can be accurately calibrated, while Rx is selected to suit the number of engine cylinders (since VR1 only has a limited range). For a 4-cylinder engine, Rx is 82kΩ; for a 6-cylinder engine, it's 56kΩ; and for a V8, it's 47kΩ.

When pin 3 of IC1 goes low at the end of the monostable period, it also resets IC2 via the negative edge detector based on IC3c. Normally, pin 13 of IC3c is held high by a 100kΩ pullup resistor. However, when pin 3 of IC1 switches low at the end of the timing period, pin 13 of IC3c is briefly pulled low via a .001μF capacitor. Pin 12 of IC3c thus briefly switches high and resets IC2 so that the next counting cycle can begin.

The two least significant digits in the display are wired to show "0" continuously. This is achieved by simply connecting six of their segments (segment "g", pin 10 is the exception) to the +9V supply rail via 1kΩ resistors. The common cathode, pin 8, connects to the 0V line.

Power for the circuit is derived from the car's battery and passes via the ignition switch to diode D2 which provides reverse polarity protection. D2 then feeds a 7805 3-terminal regulator which, together with its associated 220Ω and 150Ω resistors, delivers a regulated +9V to power the circuit.

The 33μF capacitor on the input of the 3-terminal regulator provides supply decoupling, while the 0.1μF capacitor filters out any high frequency noise.

Construction

OK, we've examined how the circuit works. Now let's build the tachometer.

The project is built on two PC boards, one for the circuitry and one for the four 7-segment LED displays. After assembly, the two boards are soldered together at 90 degrees to give a compact assembly that fits into a low-profile plastic case.

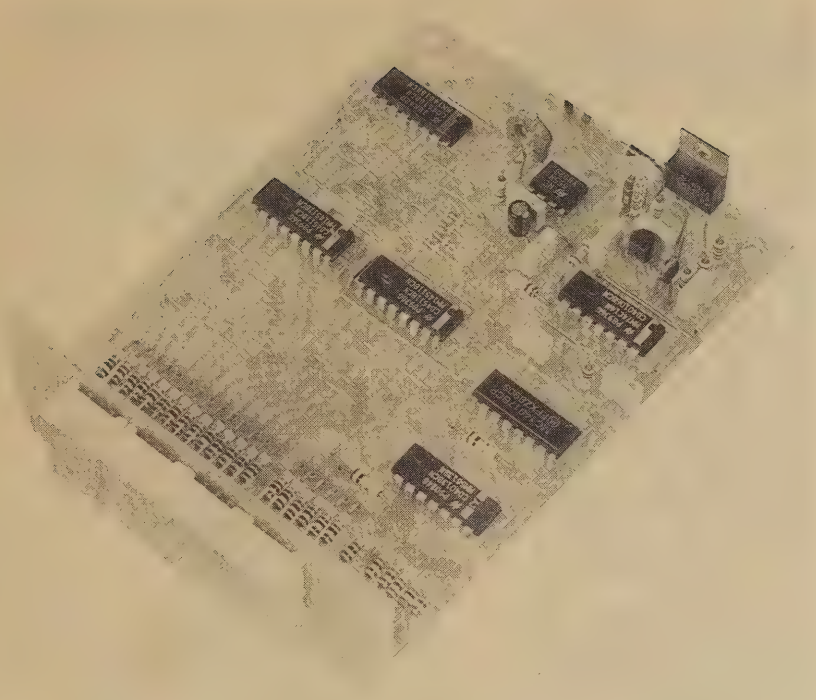
Fig.3 shows the assembly details. Before mounting any of the parts, care-

TABLE 1: CAPACITOR CODES

Value	IEC Code	EIA Code
0.1μF	100n	104
.047μF	47n	473
.022μF	22n	223
.01μF	10n	103
.001μF	1n	102

TABLE 2: RESISTOR COLOUR CODES

No.	Value	4-Band Code (5%)	5-Band Code (1%)
3	100kΩ	brown black yellow gold	brown black black orange brown
1	82kΩ	grey red orange gold	grey red black red brown
1	56kΩ	green blue orange gold	green blue black red brown
1	47kΩ	yellow violet orange gold	yellow violet black red brown
1	33kΩ	orange orange orange gold	orange orange black red brown
1	18kΩ	brown grey orange gold	brown grey black red brown
3	10kΩ	brown black orange gold	brown black black red brown
26	1kΩ	brown black red gold	brown black black brown brown
1	220Ω	red red brown gold	red red black black brown
1	150Ω	brown green brown gold	brown green black black brown



Follow the procedure described in the text when soldering the two boards together at right angles. Note that each LED display must be mounted with its decimal point at lower right.

fully check the copper sides of the boards to make sure that they have been correctly etched. When you are satisfied that they are OK, begin the assembly by installing all the wire links on the main PC board (code SC05108911).

A worthwhile tip here is to stretch the tinned copper wire to be used for the links slightly before cutting the individual lengths. This will ensure that the links are all nice and straight and prevent them from shorting to adjacent components.

Next, install the resistors. Table 2 lists their colour codes but we suggest that you also check each value on your DMM before mounting it on the PC board, since some of the colours can be difficult to distinguish. Note that some resistors in the top lefthand corner of the board are mounted end on to save space.

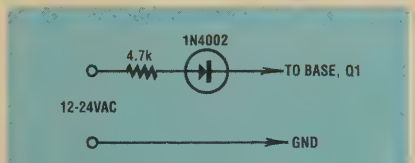


Fig.4: here's how to use the mains as a 50Hz frequency reference. Adjust VR1 for a reading of 1500 RPM on a 4-cylinder engine or 1000 RPM on a 6-cylinder engine. On a V8, adjust VR1 until the display alternates between 700 & 800 RPM.

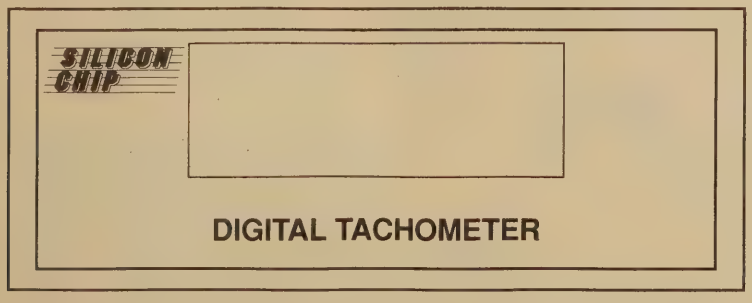


Fig.5: this full-size artwork can be used to mark out the front panel window.

As explained previously, resistor Rx is selected to suit your car's engine. Check the bottom lefthand corner of Fig.2 for the correct value for your car.

The 0.5mm fixed pitch capacitors can now be installed (see Table 1), followed by the 50kΩ trimpot, diodes D1-D6 and the transistor (Q1). Check that the diodes and the transistor are correctly oriented before soldering their leads.

Finally, install the six ICs and the 7805 regulator. Note that the ICs all face in the same direction and that the regulator is oriented so that its metal tab is adjacent to the edge of the PC board.

Display board

This board (code SC05108912) is easy to assemble since it only carries the four LED displays. Push each display down onto the board as far as it will go and make sure that it is correctly oriented (not upside down!) before soldering its pins. You can determine the correct orientation by checking the location of the decimal point - it should be at the bottom righthand corner of each LED display when the display is viewed the right way up.

The two PC boards can now be soldered together via their bus connector strips. To do this, temporarily mount the main board in the case on 6mm standoffs and butt the display board against it. Check that the bottom edge of the display board rests on the bottom of the case, then use a pencil to mark the back of the display board where the boards intersect (note: you may have to file the bottom corners of the display board slightly to clear the case mounting pillars).

The two boards can now be removed from the case and tack soldered together at each end. This done, check the assembly in the case, adjust the boards as necessary, and solder the remaining connections.

Front panel

To cut down on glare, a piece of red perspex is fitted into a hole cut in the front panel, immediately in front of the LED displays. This cutout is best made by using the published artwork as a marking template, then drilling a series of holes around the inside perimeter and knocking out the centre piece.

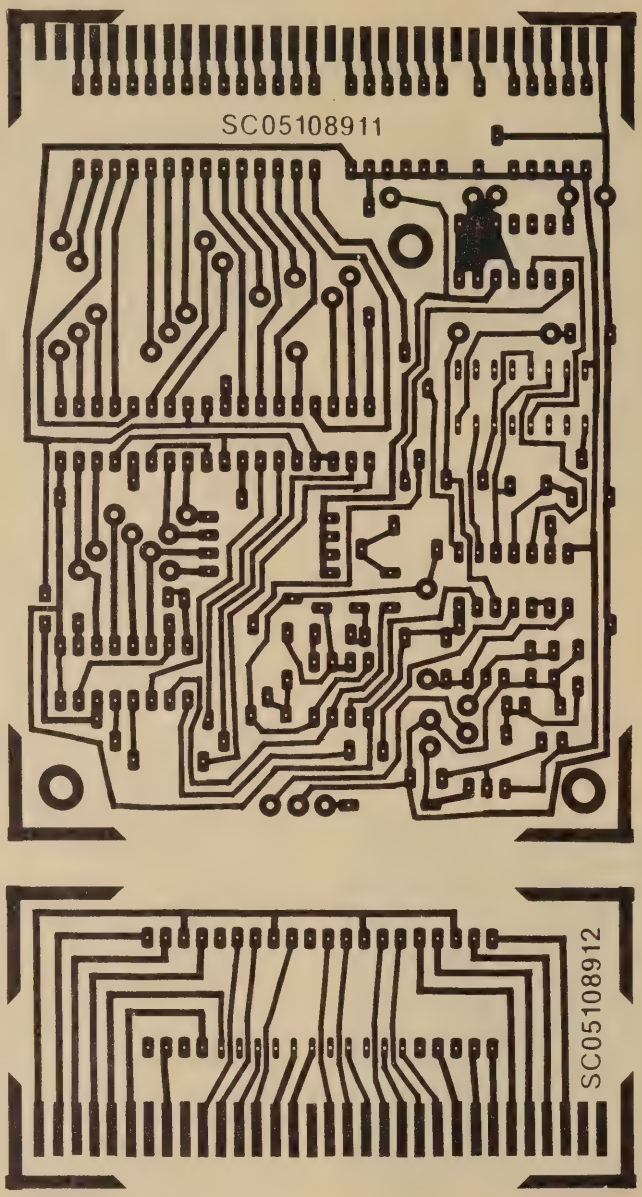


Fig.6: here are the full-size artworks for the two PC boards. Check your boards carefully before mounting any of the components.

The cutout is then carefully filed to shape until the perspex window is a tight fit. Once this has been done, remove the perspex, carefully affix the adhesive label to the panel, and cut away the panel from around the hole using a sharp utility knife.

Finally, replace the perspex window and check that it is a tight fit. If the perspex is loose, it can be secured using a spot of adhesive at each corner on the inside of the panel.

The board assembly can now be installed in the case. Note that the three external leads pass through a small grommeted hole in the rear panel. Tie a knot in the leads inside the case before passing them through the grommet to prevent the wires from coming adrift.

Testing

Now for the big test. Connect the unit to a 12V DC supply (eg, a car battery or a 12V DC plugpack) and switch on. If the project is working correctly, you should get a "000" display with the MSD blanked out.

At this stage, it's a good idea to check the supply voltage to the ICs. First, check that the 7805 regulator is delivering +9V, then check that this voltage is present on pin 8 of IC1, pin 14 of IC3 & IC7, and pin 16 of IC2, IC4, IC5 & IC6.

If you don't get the correct voltages or the display is incorrect, switch off and check your boards against Fig.3 for wiring errors. In particular, check for incorrect component placement or orientation and for missed or faulty solder joints.

Calibration

There are two ways of calibrating the Digital Tachometer: (1) you can calibrate it against another tachometer (eg, in another car); or (2) you can calibrate it against a mains-derived 50Hz frequency reference. The first method is the easiest but its accuracy depends on the accuracy of the reference tachometer. In this case, all you have to do is adjust VR1 until both tachometers give the same reading.

By contrast, the second method is extremely accurate. Fig.4 shows a suitable mains-derived calibration circuit. This uses a diode to half-wave rectify the 12-24V AC secondary voltage of a mains transformer to provide a 50Hz input waveform. The 4.7kΩ resistor in series with the diode provides current limiting, to protect the transistor.

Connect this calibration circuit directly to the base of Q1 (just solder the input lead to the top of diode D1) and don't forget the ground connection. Now switch on and adjust VR1 until you get the correct reading. This will be 1500 RPM for a 4-cylinder car and 1000 RPM for a 6-cylinder car. For an 8-cylinder car, adjust VR1 until you get a reading that alternates between 700 & 800 RPM (ie, 750 RPM)..

Finally, remove the calibration circuit, install the board assembly in the case and mount the unit on the dashboard of your car.

Don't forget that the input lead is connected to the negative side of the ignition coil primary, while the +12V supply is derived via the ignition switch. In most cars, this switched +12V rail can easily be picked up at the fusebox (use automotive connectors for all connections). Make sure that the power is derived via one of the fuses. SC

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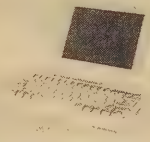

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Did you build the UHF corner reflector antenna described recently or have you just installed a new antenna? If your TV reception is still not good, add this booster unit to your TV mast & clean up those noisy pictures.

Improve your TV reception with this

MASTHEAD AMPLIFIER

ALTHOUGH intended mainly as a masthead amplifier, this unit can also be used as a distribution amplifier at the input of a multi-way splitter. It's easy to install and is suitable for amplifying both VHF and UHF TV signals, as well as FM signals.

In fact, if you live on a fringe UHF area, this unit would make an ideal companion for the UHF corner reflector antenna described recently in SILICON CHIP. But, of course, the unit is also equally suited to commercial antennas - both UHF and VHF.

Before diving in with a hot soldering iron though, it's important to realise that a masthead amplifier is not a universal panacea for TV reception ills. A masthead amplifier will not eliminate ghosting problems, for example. Nor can it clean up interference problems or give you a good picture if there is little signal at the antenna in the first place.

Nor is there much point in installing a masthead amplifier if your existing antenna and cable installation is not fully up to par. That said, there are many situations where a masthead amplifier can dramatically improve picture quality, particularly in fringe areas. Quite often, a clean signal can be obtained at the antenna terminals but at a level that's just above the onset of noise. By the time the signal has reached the TV set, the signal will be severely degraded due to cable losses.

A similar result can occur in good signal areas due to excessive losses in the distribution system. This can occur if long cable runs are involved or if the signal is split to feed multiple outlets. In these circumstances, signal losses not only occur in the feeder cable but also in matching transformers or baluns and in splitters.

Boosting the signal

The best way around this problem is to amplify the incoming signal at the antenna terminals (ie, at the masthead) before it is sent down the cable. By doing this, we can compensate for any losses that occur later in the distribution system. Alternatively, the unit can be installed ahead of a splitter unit to ensure adequate signal level at each outlet.

By JOHN CLARKE & GREG SWAIN

The circuit of the masthead amplifier is based on a Philips OM350 thick film hybrid IC which gives around 18dB of gain from 40MHz to 1GHz. This means that there is plenty of gain right across the UHF and VHF TV bands, and across the FM band (88-108MHz) as well.

Cutting costs

Most masthead amplifiers are powered from a DC supply rail that's delivered via the coaxial cable. This supply rail is typically around 12V DC and is derived from a plugpack.

This unit is different. Instead of using a DC plugpack supply, it uses a commercial "Antenna Booster Power Supply" (called the LT Telebrite) that delivers 24V AC to the cable. A rectifier/voltage regulator circuit in the masthead unit then converts this 24V AC to 12V DC to power the OM350 amplifier IC.

There are several advantages to this scheme. First, it's much cheaper than using a DC plugpack supply. A standard 12V 300mA plugpack supply will set you back about $20 - not cheap. Second, the LT Telebrite AC supply includes all the necessary screw terminals to terminate the 75Ω cables from the antenna and TV set. Unlike previous units, you don't have to make up a separate ground level adapter box to terminate (and isolate) the cables and interface the supply rails.

And third, sending AC up the mast eliminates the corrosion problems that can occur with DC supplies due to electrolysis. So the AC scheme is cheaper, easier and more reliable.

The LT Telebrite AC supply, by the way, is available only from Jaycar Electronics as part of a complete kit for the masthead amplifier. It is built into a plastic case and comes complete with a mains cord and mains transformer.

Transmission losses

We'll move on to the circuit description shortly but first let's take a closer look at the losses that occur in a TV signal distribution system. By understanding what these losses are, you'll know when and where to employ a masthead amplifier.

• Feeder cable loss: this is simply the signal attenuation that occurs in the cable between the antenna and the TV set. It depends on the length and quality of the cable and, for good quality cable, is typically about 0.1dB/metre at VHF.

Unfortunately, UHF signal losses are much higher so a masthead amplifier can make a big difference to your UHF TV reception. Of course, keeping the cable run as short as possible also helps (consistent with good siting of the antenna), and you should always use good quality cable.

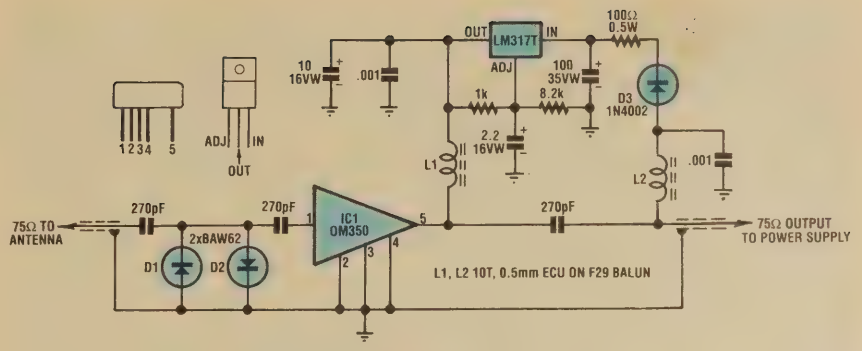
Don't use ribbon cable to distribute TV signals. Coaxial cable is less prone to ghosting and noise pickup than ribbon cable, and is less affected by wet weather as well.

• Balun loss: a matching transformer or balun is normally used to match the feeder cable (75 ohms) to the antenna impedance (300 ohms). Good quality baluns exhibit losses of less than 1dB at VHF but have somewhat higher losses at UHF.

Don't use a cheap balun if you expect good UHF reception. It may be OK at VHF but could introduce unacceptable losses at UHF, particularly in fringe areas.

• Splitter loss: this is the loss that occurs between a splitter's input and its output terminals. The greater the number of outlets, the greater the signal loss.

Typical 2-way and 4-way splitters have losses of 3.5dB and 6.5dB respectively at VHF but, as before, losses at UHF are somewhat higher.



MASTHEAD AMPLIFIER

Fig.1: the circuit is based on the OM350 thick-film hybrid IC which gives around 18dB of gain from 40MHz to 1GHz. Diodes D1 & D2 protect the IC from excessive input voltages, while D3 and the LM317 convert the 24VAC supply fed up the mast to a regulated +12V output to power the IC.

This commercial "Antenna Booster Power Supply" provides 24VAC to power the masthead amplifier. It also includes all the necessary screw terminals to terminate the 75Ω cables from the antenna and TV set so that you don't have to make up a separate adapter box.

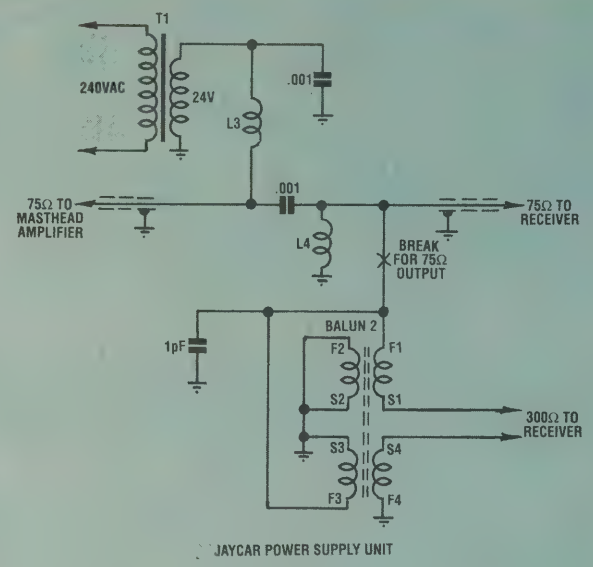
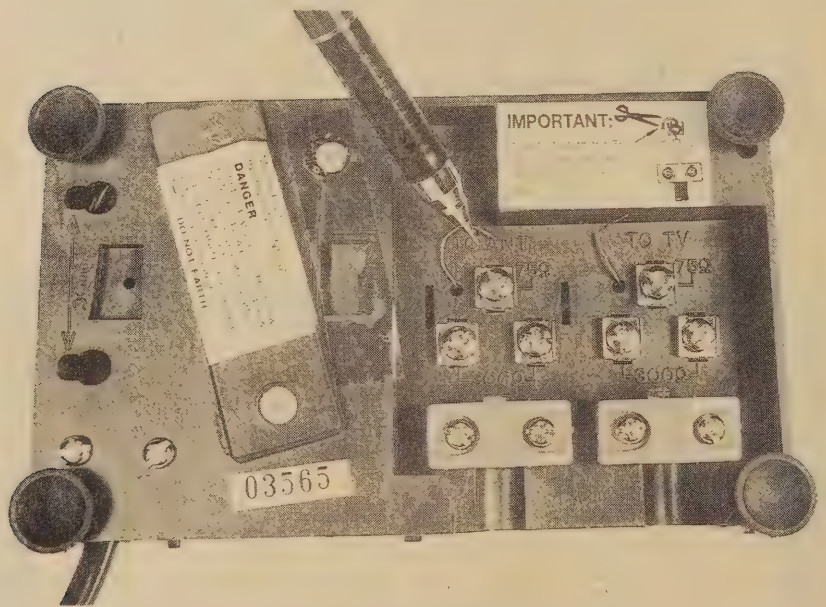


Fig.2: this is the circuit for LT Telebrite supply unit. Power is derived from a small mains transformer & this feeds 24VAC up the mast via inductor L3. L4 & its associated .001µF capacitor filter the 50Hz mains signal from the TV signal.



This underneath view of the LT Telebrite shows the clamps & screw terminals used to terminate the 75Ω cables from the masthead amplifier & TV set. Note that the two wire links must be disconnected from the screw terminals.

OK, so what about your particular installation? Should you use a masthead amplifier? In general, the answer is "yes" if distribution losses are a problem (eg, in fringe areas or in long cable runs); if reception is noisy on one or more channels and you don't wish to upgrade the antenna; or if one or more channels is borderline in quality and you want to extend the distribution system.

How it works

Fig.1 shows the circuit details of the masthead amplifier. Apart from the power supply, there are only a few components since all the required gain is produced by IC1 (OM350).

The input signal from the antenna is coupled to pin 1 of IC1 via two series-connected 270pF capacitors which provide DC isolation. Diodes D1 & D2 are there to protect IC1 from excessive input voltages, as can occur due to nearby lightning strikes, static build-up or nearby RF transmitters.

Note that BAW62 diodes are specified here because they are a high-speed switching type with very low capacitance. This means that they provide good protection for IC1 without significant signal loss. In operation, they clip any high voltage spikes to ±0.6V.

The amplified output signal appears at pin 5 of IC1 and is coupled to the feeder cable via a 270pF capacitor. Inductors L1 & L2 present a high impedance at signal frequencies and thus ensure that IC1's output is not loaded by the power supply circuitry.

At the other end of the cable, the signal is fed into the 75Ω input terminals of the LT Telebrite supply and coupled to the 75Ω output terminals via a .001µF capacitor - see Fig.2. Alternatively, the signal from the capacitor can be fed via a link to a 300Ω balun. Inductor L3 isolates the signal from the transformer secondary, while L4 and the .001µF coupling capacitor filter out any 50Hz mains signal.

Power for the circuit is derived from the 24V secondary of the mains transformer in the power supply unit (Fig.2). This 24V AC supply is coupled to the feeder cable via L3 and then fed to D3 is the masthead unit via the feeder cable and L2.

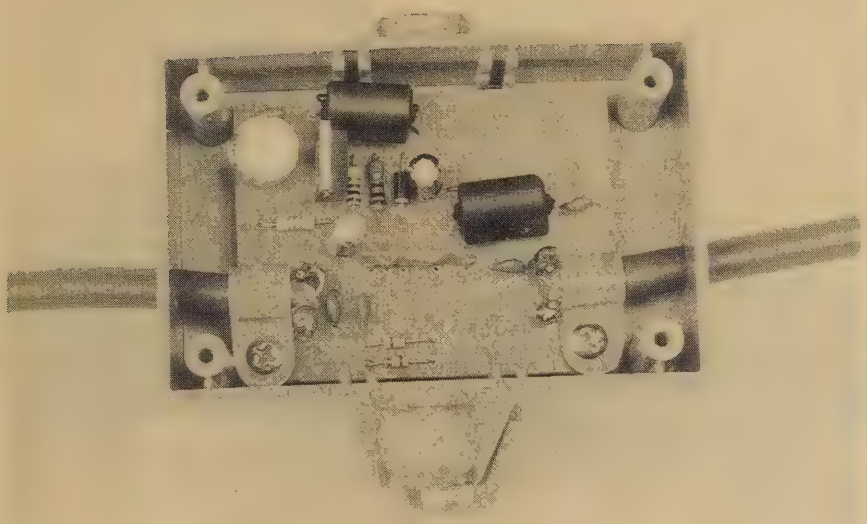
D3 rectifies the 24V AC supply and drives an LM317T 3-terminal regulator via a 100Ω resistor and 100µF filter capacitor. The 100Ω resistor limits the peak current pulses while the 1kΩ and 8.2kΩ resistors jack the output of the LM317 up to +12V.

This +12V output is then filtered and fed to pin 5 of IC1 via L1.

By now, you may be wondering why we didn't use a 12V regulator such as a 7812. The answer is that we wanted to keep the current low and an LM317 only has a quiescent current of about 100µA versus about 8mA for a 7812 regulator.

Construction

The parts for the masthead amplifier are all installed on a small PC



The two 75Ω cables are secured to the PC board using plastic cable clamps & their leads soldered to adjacent PC stakes. Use foam insulation to isolate the underside of the board from the screws used to secure the mast clamp.

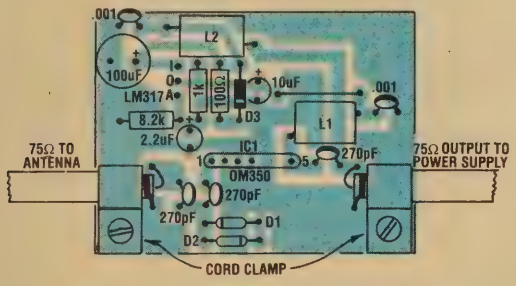


Fig.3: here's how to install the parts on the PC board. Keep all component leads as short as possible & use your DMM to check the resistor values before they are installed.

board coded SC02107911 (60 x 46mm). This board is enclosed in a small plastic case which is secured to the mast, close to the antenna, using a mast clamp (eg, Tandy's universal wall mount mast clamp - Cat 15-9573) or right angle brackets and self-tapping screws.

Fig.3 shows the parts layout on the PC board. Begin the assembly by installing four PC stakes at the coaxial cable wiring points. After that, you can install the parts in any order but make sure that they are mounted as close to the board as possible. This particularly applies to the IC and to the three 270pF ceramic capacitors since these components carry RF signals.

Use your DMM to check the resistor values before installing them on the board, as it's easy to make a mistake here. Fig.1 shows the pinout details for the OM350 and the LM317 regulator.

The two inductors (L1 & L2) are made by winding 10 turns of 0.5mm enamelled copper wire (ECW) on F29 ferrite baluns - see Fig.4. You will need about 200mm of wire to wind each balun, after which the baluns can be soldered to the board. Scrape away the enamel from the balun leads before soldering them to their respective pads.

The board assembly can now be completed by soldering the two nuts for the cable clamp screws to the copper pattern. This is best done by temporarily installing the two sets of screws and nuts, to ensure that the nuts are correctly aligned with the screw holes.

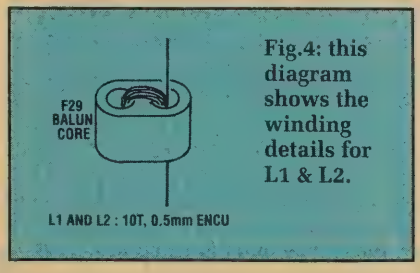


Fig.4: this diagram shows the winding details for L1 & L2.

At this stage, you are ready for the final assembly. First, drill holes in either end of the case to accept the coaxial cable, then drill the holes for the mast clamp and attach the clamp using screws and nuts. This done, strip the ends of the cables, feed them through the holes and plastic clamps, and solder their leads to the PC stakes (note: use some foam rubber to insulate the clamp screws from the PC board). The two coaxial cables can then be anchored by doing up the clamp screws.

Installation

If you intend using the unit as a masthead amplifier, it should be installed on the mast adjacent to the antenna as shown in one of the ac-

PARTS LIST

1 PC board, code SC02107911, 60 x 46mm
1 plastic zippy case, 83 x 54 x 28mm
2 F29 ferrite baluns
1 400mm length of 0.5mm enamelled copper wire
1 LT Telebrite antenna booster power supply (see text)
2 right-angle brackets (see text)
2 plastic cable clamps (to suit coax)
1 mast clamp or 2 right angle brackets - see text

Semiconductors
1 OM350 wideband amplifier (IC1)
1 LM317T 3-terminal regulator
2 BAW62 silicon diodes (D1,D2)
1 1N4002 silicon diode (D3)

Capacitors
1 100µF 35VW electrolytic
1 10µF 16VW electrolytic
1 2.2µF 16VW electrolytic
2 .001µF ceramic
3 270pF ceramic

Resistors (0.25W, 5%)
1 8.2kΩ
1 1kΩ
1 100Ω 0.5W

Miscellaneous
Screws, nuts, washers, coaxial cable, silicone sealant.

Use silicone sealant to weatherproof the case when you are satisfied that the circuit is working OK. This involves sealing the two cable exit & entry holes, the screw mounting holes for the mast clamp, and the case lid.

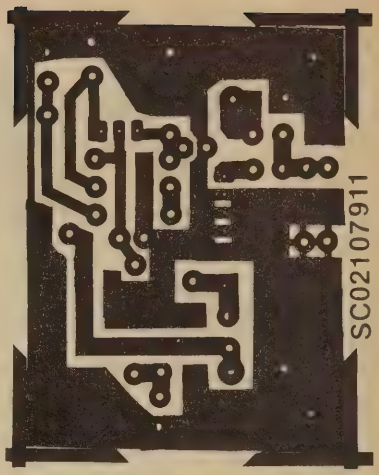


Fig.5: this is the full-size artwork for the PC board.

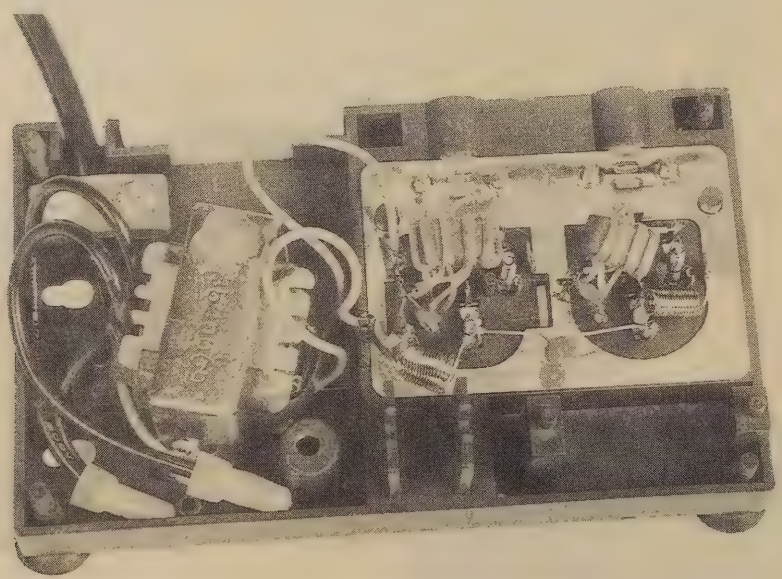
companying photographs. This arrangement will provide the best signal to noise ratio.

Run the feeder cable down the mast and into the house to the LT Telebrite supply by the most direct route possible, but avoid sharp bends or kinks in the cable. The end of the cable is then stripped and connected to the TO ANT terminals of the supply.

Note that the centre conductor goes to the 75Ω screw terminal, while the braid is forced into contact with the metal ground plane by the clamp. Do not connect the braid (or shield) to one of the 300Ω screw terminals.

A similar connection is made for the cable from the TV set to the TO TV terminals. Don't forget to disconnect (or cut) the wire links that run to the 75Ω screw terminals from adjacent holes in the bottom of the case, as indicated by the stick-on label (these links were intended to give the user the option of using 300Ω cable).

When everything is connected, apply power and check that the masthead amplifier is working correctly. You should get good noise-free pictures on all channels. If a strong local signal now causes receiver overload (as indicated by a strong interference pattern), try fitting a tuned attenuator for the offending channel right at the antenna terminals (ie, before the masthead amplifier).



The LT Telebrite power supply unit is supplied fully-built up in a moulded plastic case. Alternatively, you can make up your own AC supply & fit this into a plastic case along with the necessary parts to terminate the cables.

1/4-wave stub

A 1/4-wave stub makes a very effective tuned attenuator. This is simply a length of coaxial cable attached to the antenna terminals and cut to exactly a 1/4-wavelength of the offending channel. If the stub attenuates the signal too severely, try making it slightly shorter until you get the desired result.

Another approach is to initially cut the stub slightly shorter than a 1/4-wavelength and then tune it towards resonance using a trimmer capacitor across the open end. Experimentation is often the best answer here.

Once the masthead amplifier is working OK, it can be weatherproofed using silicone sealant. This involves sealing the lid of the case, the clamp mounting screws and the entry and exit holes for the coaxial cable.

For use as a distribution amplifier, the unit should be placed as close as practicable to the point where the cable enters the building. Of course, you must have a noise free signal to feed into the amplifier. The TO TV output from the LT Telebrite is connected to the splitter input and the splitter outputs then fed to the TV receivers. SC

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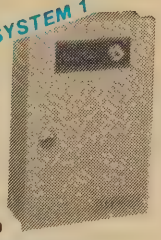

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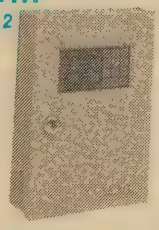
SYSTEM 2

This 4 zone panel has been suitably designed for the protection of both commercial and residential properties. It employs the latest electronic circuitry and the most up-to-date security technology. It has 4 independent individually isolatable protection circuits accepting both normally open or normally closed sensors. The panel is easily armed and disarmed via the integral inbuilt keypad.

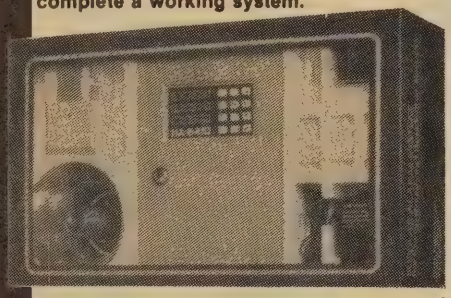


S 5485 **$249.00**

Economical Alarm System Kit

SYSTEM 3

Supplied with all major components to complete a working system.



The kit comes complete with the following components: • One Alarm Panel • One Passive Infrared Detector (P.I.R.) • One AC Power Pack • One 8 Ohm Horn Speaker • Three pairs of Magnetic Reed Switches • One 12V/1.2AH Rechargeable Back Up Battery.

S 5470 **$349.00**

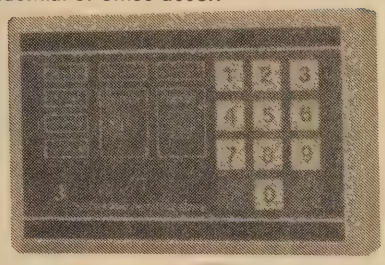
Features: • 5 Protection Circuit Loops • Independent Connections for N.C. and N.O. Sensor Switches • Arm - Disarm by Digital Access Key-pad • Multi-Station Remote Control • Warble Tone — Steady Tone Siren Driver • Adjustable Timers for Entry Delay and Siren Duration • "Latch" and "Timing" Output Relays • Remote and Local Alarm Status Indication • see Altronics '91 catalogue for full details.

Flush/Surface Mount Alarm Control Panel

SYSTEM 4

With stylish compact good looks this alarm blends smoothly into any residential or office decor.

This compact 3 section alarm panel has been designed to either surface mount or flush mount into a standard 3 gang electrical wall box. In order to provide the maximum amount of security and operation convenience the panel is operated via a 4 digit access code rather than a key. For ease of installation and service, the panel is provided with a plug in wiring harness.



S 5490 **$119.00**

FREE THIS MONTH ONLY-
100m ROLL CABLE and 4 LARGE WARNING STICKERS WITH ANY PURCHASE OF THE ABOVE SYSTEMS THATS A SAVING OF OVER $40!

Strobe Signal Lamps

Ideally Suited To Our Control Panels Above!

Uses Xenon Strobe tube for high energy flash output at a rate approx. 1 per seconds. Fantastic light energy output for the DC power used. DC input 12V 320mA.

Dimensions: 97 diam 50 H. Two colours available.

S 5455 Blue **$34.95**

S 5450 Red **$34.95**

Super Small PIR Detector

Very Unobtrusive.

Incorporating the latest technology this compact Passive Infra Red Detector (P.I.R.) features Pulse Count Triggering which virtually eliminates false alarms. See Altronics '91 catalogue for full details.

Ideally Suited To Our Control Panels Above

Incredibly Small
Only 55 x 31 x 73mm

S 5302 **$79.00**

Digital Access Keypad

This digital access keypad is a 12-button electronic coded combination lock. It provides two sets of secret codes for the owner. There are 11880 different combinations possible for secuirty key and 132 different combinations possible for panic. The secret codes may be instantly changed by the owner. by just simply rearranging the code jumper pins on the PCB. See Altronics '91 catalogue for full details.

Ideally Suited To Our Control Panels Above!

S 4200 **$69.95**

Alarm Stickers

200mm x 75mm — S 5400 **$1.95**

70mm x 25mm — S 5410 **$3.95**

UHF Microprocessor Controlled Wireless Security System

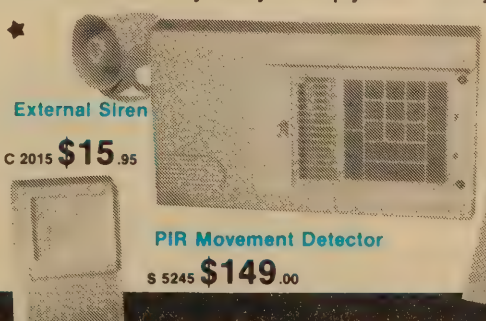
Apart from the flawless operation of the system one of the great features is its application with rented or leased premises — let's face it, money spent on installing a wired system in your home or office, factory, etc is irrevocably lost when you move on. With this system you simply take it with you.

Complete System Includes:

1 x Control Panel
1 x Passive Infra Red Detector/Transmitter
1 x Door/Window Reed Switch/Transmitter
1 x Hand Held Remote Control/Transmitter
1 x Horn Speaker — 10 watt/wired
1 x 240V AC adaptor
1 x 1.2Ah Back-up Battery
1 x Set of batteries for all transmitters

S 5240 **$649.00**

For Additional Components See Right



External Siren

C 2015 **$15.95**

PIR Movement Detector

S 5245 **$149.00**

Wireless Remote Keypad

S 5255 **$129.00**

Personal Remote

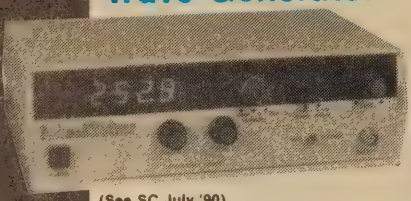
S 5250 **$59.00**

Door/Window Reed Switch

S 5247 **$69.00**

PHONEORDER TOLL FREE ALTRONICS 008 999 007

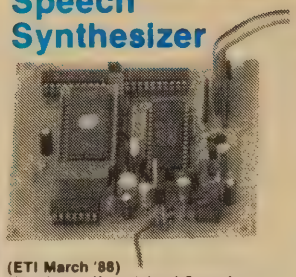
High Performance Digital Sine/Square Wave Generator



(See SC July '90)
This new digital Sine/Square Wave Generator uses high speed CMOS ICs and a digital filter IC to produce sine and square waves over the frequency range from 0.1Hz to 500kHz. It also features a 4-digit frequency readout and an output level control.
Like most high quality audio function generators, this digital generator covers a very wide frequency range — from 0.1Hz to 500kHz — and it does so with rock solid amplitude stability. There is no bouncing about of the amplitude as you change frequency (as is inevitable with termistor stablised Wien Bridge designs).

K 2547 **$175.00**

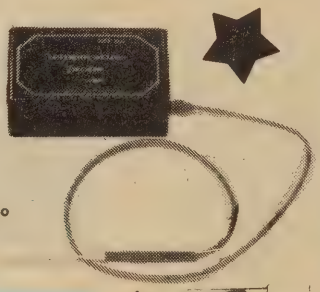
Speech Synthesizer



(ETI March '88)
Here is a self contained Speech Synthesizer that does not require a computer to control it.
This small, simple circuit contains all the necessary components to make your favourite possessions speak. It can be connected to almost any appliance, vehicle or home remote control system to let you know when the kettle has switched off, the doors are locked or the water in the radiator is boiling. The inputs are coded and priority message reading means warnings are heard instead of greetings etc if two messages are sent at the same time. Blank Eprom included to all you to programme the messages you want.

K 9500 **$95.00**
K 9502 Pre-Programmed Eprom for K9500 $20.00

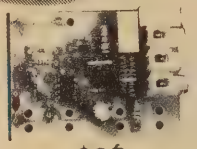
Low Cost Temperature Probe



Here's an easy to build probe which adapts a multimeter into a general purpose thermometer.
Measures accurately from -20 deg C to +120 Deg C

K 2570 **$21.95**

Touch Lamp Dimmer



(See SC June '89)
Impress your next dinner guests with this nifty "Touch" Lamp Dimmer
Are you still persisting with one of those old knob type light Dimmers? Well here is a light dimmer which can turn your lights on and off or just dim them by touching the decorative plate. Extremely safe operation
K 6329 with gold plate
K 6330 with silver plate

Normally ~~$35.00~~
This Month **$30.00**

Get 240V AC Mains Power From Your 12V Battery With These Handy Inverter Kit Sets

Depending on power capacity the various models will power TV Sets, HI FI Turntables, AC Lighting, Electric Drills, Angle Grinder and 100 and 1 Appliances

12/240V 40 Watt Inverter

(See EA Aug '85)
This inverter is ideally suited for powering low wattage mains appliances from the car battery while camping. This cconsiderably improves the comfort level of the civilised camper. Similarly, it has uses in boating. Typically, it can be used to power an electric shaver, electric blanket, electric can opener or a 40W light bulb.

K 6705 **$99.00**

300 Watt Inverter with Auto Start

(See EA April '88)
• Super Compact - kit is supplied with tough ABS case **• Uses High Efficiency Toroid Transformer** thus keeping down heat dissipation, battery drain and weight **•Auto start** draws power from your battery only when appliance is plugged in and "turned on" ie battery can be left permanently connected if req **•** Voltage regulated **• Current regulated • Current overload.**

K 6750 Complete Kit $279.00
K 6755 Fully Built & Tested $370.00

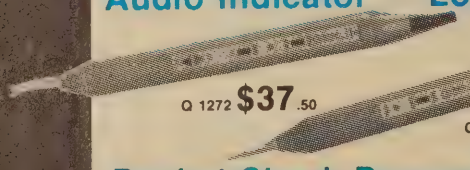
STOP PRESS — 300 WATT INVERTERS NOW INCORPERATE NEW IMPROVED CIRCUITRY. EVEN BETTER VALUE!!

Powerhouse 600W Inverter

(See EA Dec '87)
This inverter has the capability to produce 600 watts of mains power which will run a fantastic array of appliances. It would be ideally suited to running power tools, lighting (including fluros), electric motors and much more. It can be either used as a portable unit or permanent fixture. A must for farming, camping, mining, boating, remote settlements and where ever else 240V power isn't available. Can be configured to operate off either 12V or 24V DC.

K 6774 12V Fully Built $625.00
K 6770 Kit Version $499.00 **K 6775 24V Fully Built $625.00**

20MHz Logic Probe with Audio Indicator

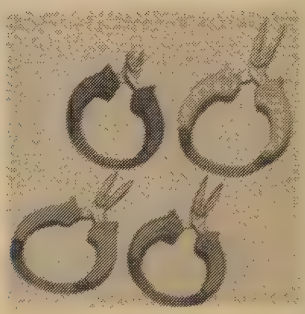


Q 1272 **$37.50**

50MHz Logic Probe with Logic Pulser

Q 1280 **$54.95**

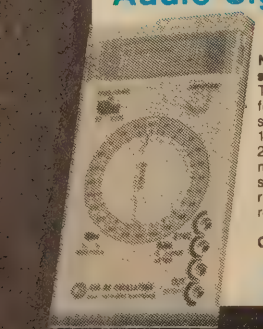
Palm Grip Tools



Diagonal Cutter T 2700 **$9.95**
Flat Nose Plier T 2710 **$9.95**
Needle Nose Plier T 2720 **$9.95**
Curved Needle Nose Plier T 2730 **$9.95**

Buy The Set For $30.00
HURRY THIS MONTH ONLY!

Pocket Sized, Personal Audio Signal Generator



Now you can have a full function audio signal generator for less than $100!
This pocket sized oscillator has all the features of a large bench oscillator. 46 preset switched frequencies ranged from 20Hz to 150kHz. eg. 1kHz, 1.2kHz, 1.5kHz, 1.8kHz, 2kHz, 2kHz etc. Smaller than most multimeters, this is ideal for technicians, servicemen, students and hobbyists who require an accurate and reliable oscillator ready to use anywhere.

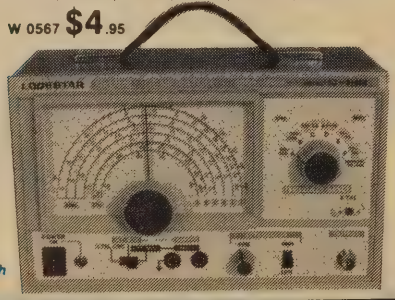
Q 1542 **$99.00**

BONUS! With Free Carry Case This Month (Worth $12.50)

Hobby Pack Heatshrink

Includes: (Internal Diameter)
1.6mm, 2.4mm, 4.8mm, 6.4mm, 12.7mm, 19mm.

W 0567 **$4.95**



RF Signal Generator

An absolute necessity for radio servicing. With provision for both internal and external modulation
Frequency Range 100kHz-150 MHz in 6 ranges

Q 1550 ~~$299.00~~
This Month **$249.00**

PHONEORDER TOLL FREE ALTRONICS 008 999 007

8 Ohm Economy Weatherproof Horn Speakers

PVC Construction

C 2015 10 Watt ~~$15~~.95

This Month's Special **$13.95**

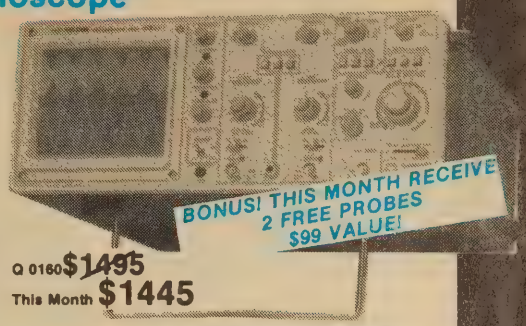
Aluminium Construction

C 2025 15 Watt ~~$39~~.50

This Month Only **$35.00**

40MHz Dual Trace Oscilloscope

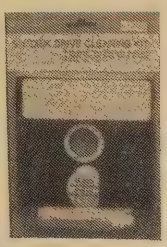
A superb oscilloscope for technicians and engineers working on projects where other instruments would be stretched beyond their capabilities.
Where precise measurements of computers, CD's, digital videos, RF applications, high speed digital,and other high speed equipment is a must.
With Features Like:
• Delayed sweep for partial waveform expansion. • Channel 1 signal output for use with a frequency counter • CH2 polarity inversion switch • Vertical deflection magnification, X5 • Switchable chopping frequency • Scale illuminating system • B Intensity control for bright, magnified waveforms • Variable hold-off for observation of waveforms with complex periods • Single sweep mode for one time or other suddenly occuring events • Sweep magnfication, X10 • Signal delay line for accurate view of high frequency pulse leading edge • Trigger preset function.



Q 0160 ~~$1495~~

This Month **$1445**

Disk Cleaners



Now-a-day's computer hardware and software doesn't come cheap, and is often difficult to replace. So protect your valued investments with our 5¼" floppy disc cleaners.
D 1807 3½" Kit
D 1809 5¼" Kit

$5.95

Rack Case Clearance

Save Up To 40%

H 0400 3 Unit Black Economy Case	**$49.95**
H 0404 1 Unit Case Grey F/Panel	**$40.00**
H 0405 2 Unit Case Grey F/Panel	**$45.00**
H 0406 3 Unit Case Grey F/Panel	**$48.00**

Sorry not available from Altronic Dealers at these prices

5M Telephone Extension Leads

(Non Austal Approved)

P 0991 **$5.00**

TO3 Heatsinks

NORMALLY ~~$1.50~~

SPECIAL THIS MONTH ONLY

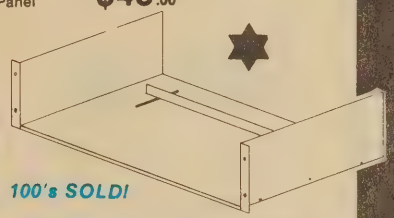
1-9 **.40¢**
10-99 **.30¢**
100 up **.20¢**

Amazing Bargain

Rack Shelf

PROUDLY MADE IN AUSTRALIA

100's SOLD!



This sturdy 3 unit high rack shelf is designed to accommodate a vast range of equipment which does not have rack mounting capability. Fantastic for videos, tuners, CD players, amps, tape decks and anything else that is under 3 unit high and 300mm deep. It even has an adjustable bracket which stops the appliance moving backwards. Supplied in flatpack form - easily assembled in minutes. Hardware supplied.

H 5359 **$49.95**

Plasma Lamp Display

21st Century Entertainment Fascinate Your Friends!

Amazing! Pulsating high voltage plasma discharge continually changes shape and direction. Mode selectable to either fingertip control or sound activated. For example, from voice or sound system. Provides endless fascination as it sizzles and arcs.
Supplied complete with AC mains adaptor.

A 0120 Normally ~~$199~~.00
Save $100 *Up till now similar lamps have sold for $1000 and more!!*

This Month Only **$99.00**

Super Guard Household Alarm System

Super Guard is a comprehensive low cost alarm system. Simple to install and operate, this system is great for home or small office.
Three sets of door/window reed relay proximity switches are supplied. Additional switches can be installed as desired. These switches can be connected to the "Instant alarm" circuit (windows) or "Delayed Alarm" circuit, eg front or rear door thus enabling you to disarm the system when re-entering the house.

S 5465 ~~$129~~.00

Ideal for the Shed or Garage

A Crazy **$30.00**

VIFA 2 Way 100 Watt Weatherproof Speaker

Audio Purists. This Is For You!

C 0970 Black C 0972 White

Normally ~~$199~~.50 ea

This Month **$310.00 PR**

Redford and **Scan Audio** have combined resources to develop this high performance weatherproof speaker system. The heart of the system is the now famous 5" VIFA Woofer/Midrange, computer optimised for use in a 5 litre Bass reflex cabinet. The classic VIFA 19mm ferro fluid Dome Tweter is incorporated with the crossover network as employed with the SA-50 bookshelf system. The system is fitted with a unique overdrive protection device enabling amplifier input of up to 100 Watts without damage. The combination of the internationally acclaimed VIFA drivers with the rugged **Redford** extruded aluminium enclosure give an overall performance and appearance that is superior to any competitive weatherproof speaker on the Australian market.
Each speaker is supplied complete with mounting brackets.

High Performance 2 Way Flush Mounting Full Range 60W Speaker System

"Highly recommended. I found it difficult to pick the difference between the Altronics C 0880, the American Sonance and Boston Acoustic Systems, both costing around $600 a pair"
— John Negus leading WA Audiophile

Building that extension? What great speakers to install. Designed to install into ceilings or walls this slim profile attractive speaker system/grille assembly will compliment any sound system. Once installed the finished unit blends beautifully into any decor. (The grille assembly can be painted over in the same finish as walls or ceilings if required).
Installation is simplified by the use of a mounting frame (which could be installed during construction) which the speaker assembly attaches to. Full mounting kit (even screws) supplied.

C0880 ~~$125~~.00 ea

This Month's Special **$99.00 ea**

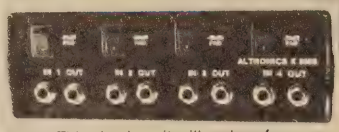
Front Grille Not Illustated.

PHONEORDER TOLL FREE ALTRONICS 008 999 007

JUST ARRIVED - EXCITING NEW KITS FROM ALTRONICS

Quad 'DI' Box for Stage And Studio

See E.A. June '91



This simple unit will replace four separate direct injection (DI) boxes, but at a fraction of their total cost. It offers excellent performance, and is ideal for connecting a bank of electronic musical instruments to a standard mixing desk.

K 5555 **$79.95**

DC-DC Converter For Car Amplifiers

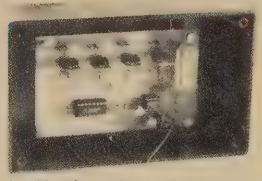
See S.C. Dec '90

This DC-DC converter will allow you to use a hifi power audio amplifier in your car to provide good quality sound. It provides split supply rails which can be adjusted to suit your amplifier.

K 4100 **$139.50**

Simple 12 or 24V Light Chaser

See S.C. April '91



Looking for a simple circuit to sink your teeth into? This 12V light chaser has four separate channels, variable chase rate, fuse protection and uses just two ICs. There are four channels and each channel can handle up to 36W.

K 5810 **$39.95**

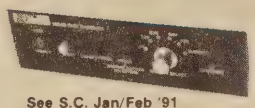
Dual Tracking Power Supply

See S.C. April '90

Delivers a hefty 1.5A at 0 to 50V. This dual tracking power supply is a must for your workbench. The two rails track each other exactly on any voltage. Precise voltage is obtained with the multi-turn rotary control. It also has a clear display and meter movement, a dropout indicator and load ON/OFF switch. Housed in a medium sized instrument case with a silver anodised pre-punched and screened front panel.

K 3380 **$229.00**

Fast Charger For Nicad Batteries



See S.C. Jan/Feb '91

This Nicad Fast Charger is designed to operate from a 12V car battery. It can charge nicad battery packs from 6-12V at currents up to 6A, or you can wire the circuit to charge battery packs up to 30V at reduced current.

K 1660 **$129.00**

Inverters for Fluorescent Lights

See S.C. Feb '91

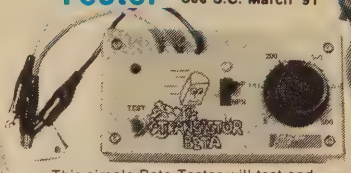
These DC-AC inverters, are suitable for fluorescent lights rated up to 16 and 40 watts. Fantastic for camping, back yard sheds etc.

K 6350 16W Version **$35.95**

K 6360 40W Version **$43.95**

Transistor Gain Tester

See S.C. March '91



This simple Beta Tester will test and measure the gain of most bipolar transistors. You simply connect the transistor, press the button, rotate the knob until the LED lights, and read the gain from the calibrated dial scale.

K 2534 **$25.00**

FM Radio Microphone

This simple FM Microphone Kit can be built in next to no time and only requires an ordinary FM radio for reception. • Works in the standard 88-108MHz FM range • Runs from a single 9V battery • High sensitivity microphone supplied • Long range transmission (up to approx 30m).

K 1106 **$11.50**

Two Channel Pro Power Amp 90 Watts Per Channel

This stereo amp is ideal for background/foreground applications. Fantastic for restaurants, shops, disco's, aerobics, PA sound systems and home.

• 90 watts RMS per channel minimum into 8 Ohms from 20 to 20,000Hz with less than 0.05% THD • 2 large power meter indicators • EIA panel with handle device • XLR socket for speaker terminal • Output relay to eliminate turn-on and off transients • Dimensions: (W x H x D) 482 x 92 x 295mm • Weight: 10.5kgs • Ideally suited to A 2210 stereo tuner.

A 2040 ~~$625.00~~ INTRODUCTORY OFFER **$599**

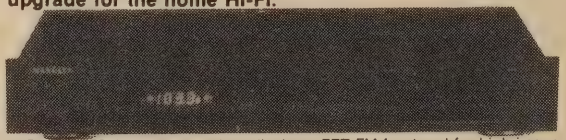
Gell Cell Charger

Charging current 300mA at 12V. Great for any Gell Cell.

M 9020 ~~$12.50~~ This Month **$10**

AM/FM PLL Tuner

This fantastic tuner is the ideal add-on to any sound system. Can be used as background of music in restaurants, shops etc or any PA application. Also a great upgrade for the home Hi-Fi.



• Digital LED frequency readout display • FET FM front end for high image rejection • Phase-linear ceramic filters are incorporated in both AM and FM IF section • 20 station memory • Phase-lock loop (PLL) IC for FM multiplex stage • Dimensions: (W x H x D) 435 x 60 x 232mm • Weight: 3kgs.

A 2210 ~~$229.00~~ INTRODUCTORY OFFER **$199**

ALTRONICS

174 Roe St. PERTH W.A. 6000 Phone (09) 328 2199
PHONE ORDER TOLL FREE 008 999 007
MAIL ORDER C/- P.O. Box 8350 Perth Stirling St. W.A. 6849

STANDARD DELIVERY & PACKING CHARGE $5.50 to 1Kg, $8 1Kg-5Kg.
AUSTRALIA WIDE — Via. Australia Post allow approx 7 days for delivery.
OVERNIGHT JETSERVICE Up to 3Kg is $10.00, 3Kg to 5Kg is $28.00. **Overnight Jetservice Courier** for delivery next day Country areas please allow additional 24-48 hours

HEAVY HEAVY SERVICE — All orders of 10Kgs or more must travel Express Road — Please allow 7 days for delivery. $12.00 to 10Kgs. $15.00 over 10Kgs.
INSURANCE — As with virtually every other Australian supplier, we send goods at consignees risk. Should you require comprehensive insurance cover against loss or damage please add $1.00 per $100 of order value (minimum charge $1). When phone ordering please request "Insurance".
TOLL FREE PHONE ORDER — Bankcard, Visa, Mastercard Holders can phone order toll free up to 6pm Eastern Standard Time. Remember with our **Overnight Jetservice** we deliver next day.

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REMOTE CONTROL

BY BOB YOUNG

Large servo amplifiers for model yachts & machinery

This month, we will move on to some special applications of large servo amplifier technology. These are used for the remote control of machinery and heavy vehicles, although their principles of operation are similar to those used in model aircraft.

Many areas of model R/C require mechanical outputs which are quite different from the normal servo which delivers a rotary output restricted to approximately 100 degrees of movement and 1-3kg of thrust. These outputs include large servos for quarter scale aircraft (or bigger), robotic puppets and sail winches, plus speed controls for electric propulsion and remote switches.

In one special case, where I radio-controlled a full size Volkswagen 1600 TLE, I used servos which delivered 30kg of thrust. Thrust in this case is defined as the actual force measured on a spring balance from the output arm used (I find this a little more descriptive than the usual kg/cm). The servo motors in this last case were Valiant windscreen wiper motors which had to be forced cooled from a separate blower. As Hoges would say, "now that's a servo".

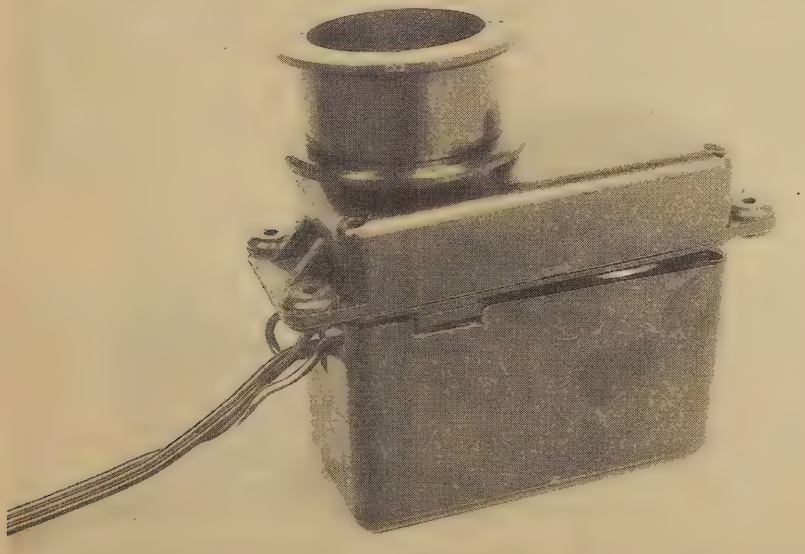


Fig.1: this servo is designed specifically to serve as a winch for model yachts & features a multi-turn output for hauling in the sheets.

It was in the Volkswagen job that I discovered the problems of underpowered servos in which compensation is made by recourse to lower gear ratios. The result is a servo of adequate thrust, but uncomfortably long transit times. In a vehicle designed to travel at speed, long transit times on the steering and brakes make for some hair-raising experiences.

I remember having a chuckle when the Apollo astronauts complained about the difficulties they had in steering their moon buggy. They had a seven second transit time on the steering from memory, on a vehicle designed for about 10km/h top speed.

The script on the Volkswagen commercial called for a top speed of 80km/h so that it could overtake the camera car and pull away into the distance. Because of the tight time allowed for the job, I found to my horror that I had to use a gearbox which resulted in a 4-second transit time on both the brakes and steering. The difficulties in steering at this speed were indescribable.

On one occasion, I cut in too early on the camera car after overtaking it and the driver braked too heavily. As a result I fell off my seat, dropped the transmitter and had to go looking for it. It the meantime, the Volkswagen, given its freedom, had taken off across the nearest paddock, dragging a barbed wire fence behind it. Volkswagen had that car back on the road the next morning, complete with a new set of

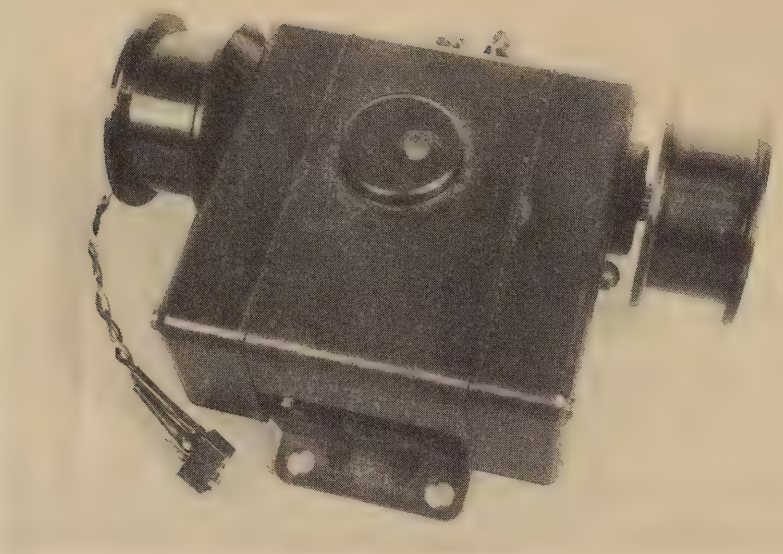


Fig.2: this servo is basically the same as the one shown in Fig.1 but features a double drum output. This is very useful in model yachts, as usually there are two sails which require trimming: the jib and the mainsail.

passenger side body panels, and the commercial went to air in due course. Such are the joys of commercial TV work.

Winch servos

The photo of Fig.1 shows a special type of servo designed specifically as a winch for model yachts. Note the unusually large size of this servo, which is not under weight restraint to the same degree as an aircraft servo. The main criteria for this type of winch is output power and multiple turns on the output drum.

The multiple turn output is required because the drum is used to haul in the sheets (sheets being the ropes, just to confuse non-yachties). The number of turns is usually about 8-12, depending upon the yacht size and servo power.

As a matter of interest, we used to test our winches by lifting a bucket off the ground. If the winch passed the bucket test, we felt it was OK. No big deal did I hear you say? Perhaps I should have mentioned that the bucket contained two house bricks, each weighing 4kg. This was the thrust necessary for an "A" class yacht working in heavy weather.

There are also some very large servos designed for large model aircraft and these may be readily converted into a "BAR" type winch. By using a large output arm, the amount of throw is sufficient to provide the necessary travel to position the sails in the correct location. This overcomes the problem of the sheets becoming tangled or slipping off the drum.

Another consideration in setting up a winch is the transit time or time taken to haul in the full length of the sheet under heavy conditions. There is little point in using the drum as the major source of the mechanical advantage by the simple expedient of using a smaller diameter drum, because this only increases the time required to complete the increased number of revolutions. The speed of manoeuvring when rounding a buoy is dependent upon the speed with which the sails can be retrimmed and long transit times can be costly in terms of race times.

Thus, we soon arrive at the conclusion that servo power is the all important factor in winch design and servo power begins with motor size, particularly armature diameter and winding resistance. In fact, the motor more or less dictates the servo size and the servo is thus designed around the servo motor.

The servo illustrated in Fig.1 uses a 5-ohm 26mm motor and provides plenty of grunt when fitted with an amplifier capable of delivering the required amount of current. Another important consideration here is the voltage drop across the output transistors. If these are poorly selected, it can result in downgraded servo power because some of the power is lost as heat.

The photo of Fig.2 shows what is essentially the same servo, this time fitted with a double drum output. This is very useful in model yachts, as usually there are two sails which require trimming: the jib (or little sail close to the pointy end) and the mainsail (or large sail at the blunt end).

One usually tries to sail the yacht with the pointy end heading more or less into wind. The degree to which the yacht can point into wind is a measure of its overall efficiency. To achieve this requires good winches of great power and accuracy.

Circuit description

The diagram of Fig.3 shows the circuit of a typical winch amplifier, based on the popular NE544 servo amplifier IC. This is fitted in turn with a power amplifier to provide the current required by a 5-ohm motor. The NE544 can drive a small motor direct provided it draws less than 300mA but anything over this requires additional amplification.

In the amplifier shown in Fig.3, VR1 is a 5kΩ feedback pot which is mechanically coupled to the output shaft of the final gear on the servo drive chain. R14 & R15 provide travel adjustment and wiper centring. This mechanical coupling can be in the form of a reduction gear set to provide the required number of turns on the output drum. Fine adjustment of the number of turns can then be obtained electronically by varying the values of R14 & R15.

A similar result can be obtained by adjusting R10. However, this will also shift the neutral point and there is no easy way to readjust the neutral, although R14 & R15 can be used to some effect for this purpose.

Input capacitor C7 provides DC isolation and C8 is the pulse stretcher. Be sure that only a good quality barrier ceramic is used for C8. Do not use TAG tantalum capacitors in this location. C4, C5 & C6 are all critical to temperature and therefore use only TAG tantalum capacitors here. Do not use low voltage ceramics.

Transistors Q1-Q6 form a bridge driver amplifier for the IC output.

Note that a separate battery may be used to power this amplifier if re-

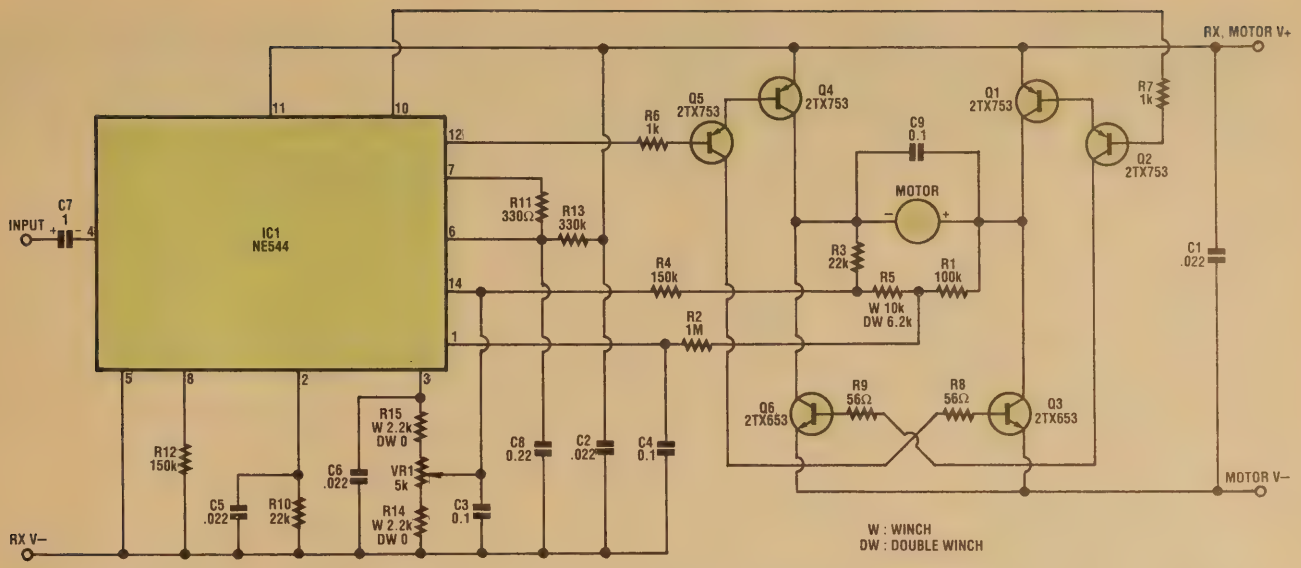


Fig.3: this diagram shows a typical winch circuit, based on the popular NE544 servo amplifier IC. In this circuit, IC1 drives a bridge amplifier circuit (Q1-Q6) to increase the current drive to the motor. The NE544 can also drive a small motor direct, provided it draws less than 300mA.

quired. This is a good idea for, in many cases, sheets can tangle, stall the motor and thus flatten the battery. If the receiver is running from this battery, then control is lost and a long swim is called for.

As an additional safety feature, a fuse may be installed in this secondary battery to protect the power amplifier and servo motor. These things sometimes take a long time to repair and can end up being quite expensive. There is also an element of flexibility added to the design as a result of using a separate battery, as the drive voltage to the motor can be increased without the need for voltage regulation on the servo amplifier.

Feedback resistor R2 provides the damping required to prevent overshoot and oscillation around neutral and is a critical adjustment. Too much damping and the servo shuts down too early. Also, the neutral is broadened and thus the servo is less accurate. The worst case here is that the servo comes to rest before neutral and leaves a residual current which may be just below the motor start current.

This can be quite high in some motors and overheating of the output transistors can occur. Conversely, too little damping and the servo overshoots and oscillates before coming to rest, again increasing current consumption and heating the transistors and motor. In the worst case, the servo never comes to rest and continues to oscillate, which will quickly destroy the output transistors and motor.

The ideal situation is called "dead beat" and is difficult to obtain. The most accurate situation is to allow the servo in its unloaded condition to overshoot once and then return to rest. When the servo is loaded mechanically, this arrangement will perform very close to dead beat.

C9 is a suppression capacitor, to eliminate motor noise. Sometimes a resistor four to five times the motor resistance is used in parallel with the motor as well. The motor noise can be quite troublesome and difficult to get rid of with some brands of motor. In this case, use a capacitor from each brush terminal to the motor case.

Do not ground the case for sometimes the armature winding can short out to the case and then bang goes the servo amplifier.

As a last resort, RF chokes may be fitted in series with each motor lead but make sure they can carry the starting current of the motor.

Fig 4 shows the circuit of a simple switch used to drive a relay for those odd jobs around the model which call for "momentary on" contact. Horns, whistles, dropping bombs and waving pilots all call for this type of circuit. By replacing RL1 with a latching relay, a "press-on press-off" output can easily be obtained. And although I have never tried it, I see no reason why RL1 cannot be replaced with a bipolar relay and driven directly from the NE544 bridge, giving a true toggle switch output.

Once again the old faithful NE544 is called into service. Note that there is no requirement for a gear driven feedback pot here and so VR1 is now a standard trimpot. SC

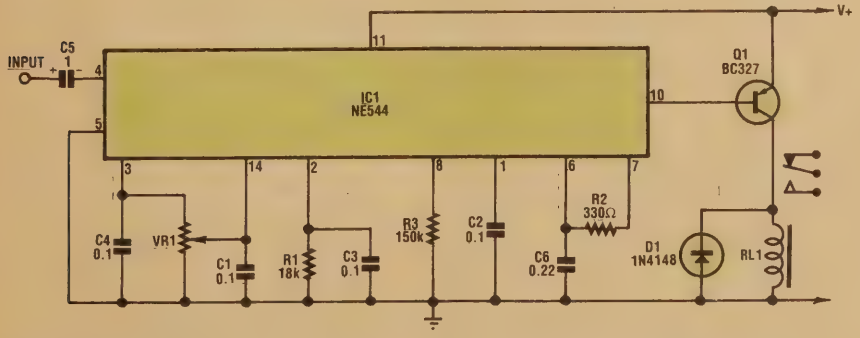
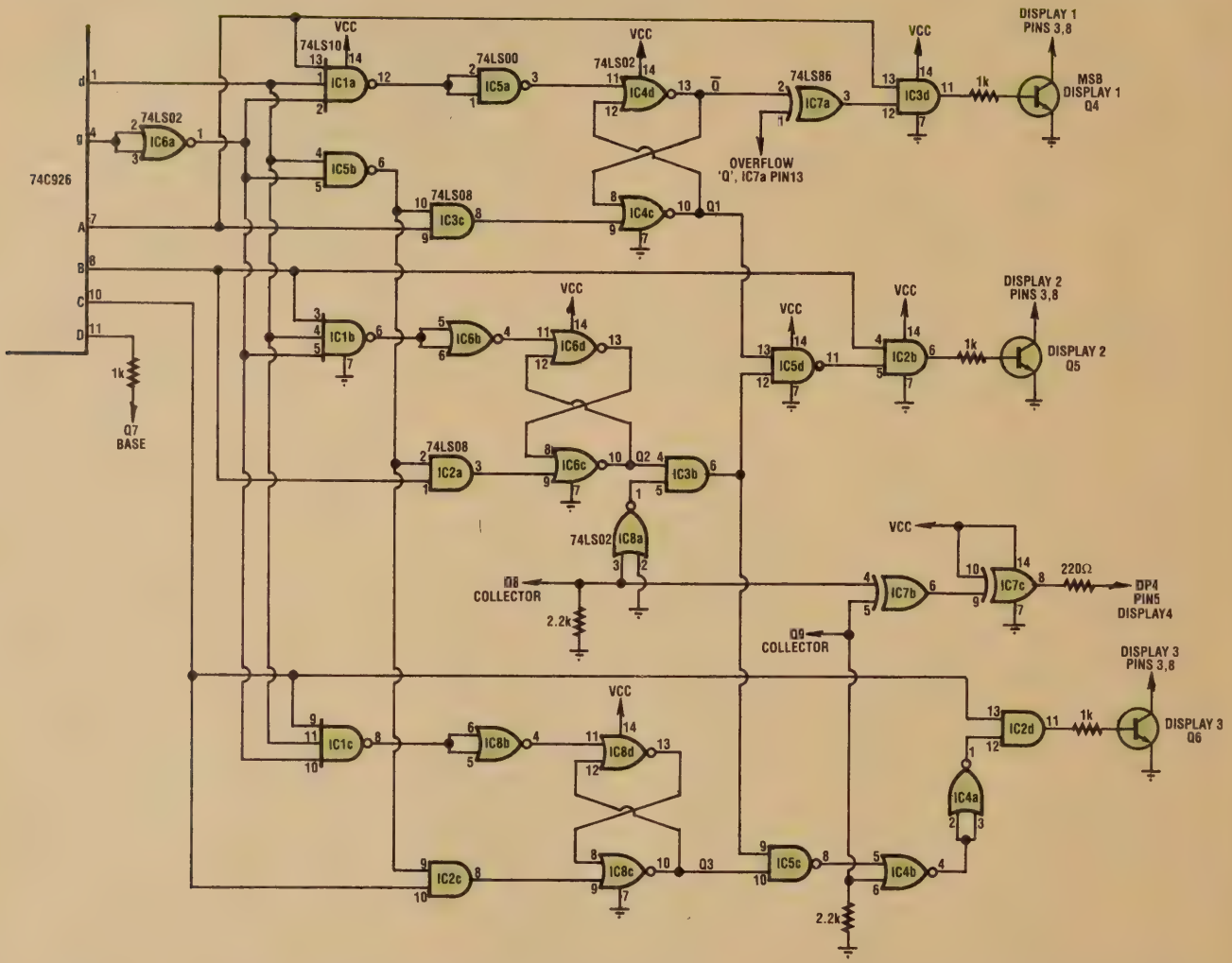


Fig.4: this simple circuit can be used to drive a relay for those odd jobs that require a "momentary on" contact but can also easily be modified for press-on press-off operation.

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.



Leading zero suppression for the capacitance meter

This circuit blanks out all the leading zeros of the display used in the 4-Digit Capacitance Meter (SILICON CHIP, May 1990). It uses three identical latches, one each for displays one, two and three. It is inserted between the A, B and C outputs of the 74C926 and the digit driver transistors, Q4, Q5 and Q6.

Consider control of the latch formed by NOR gates IC4c & IC4d. The latch is set when we have segment "d" high and segment "g" low during the drive period for display 1 (ie, the unique condition occurring when a "0" would be displayed). Conversely, the latch is reset when this is not true. The other two latches (ie, IC6c, IC6d and IC8c, IC8d) are controlled in the same manner.

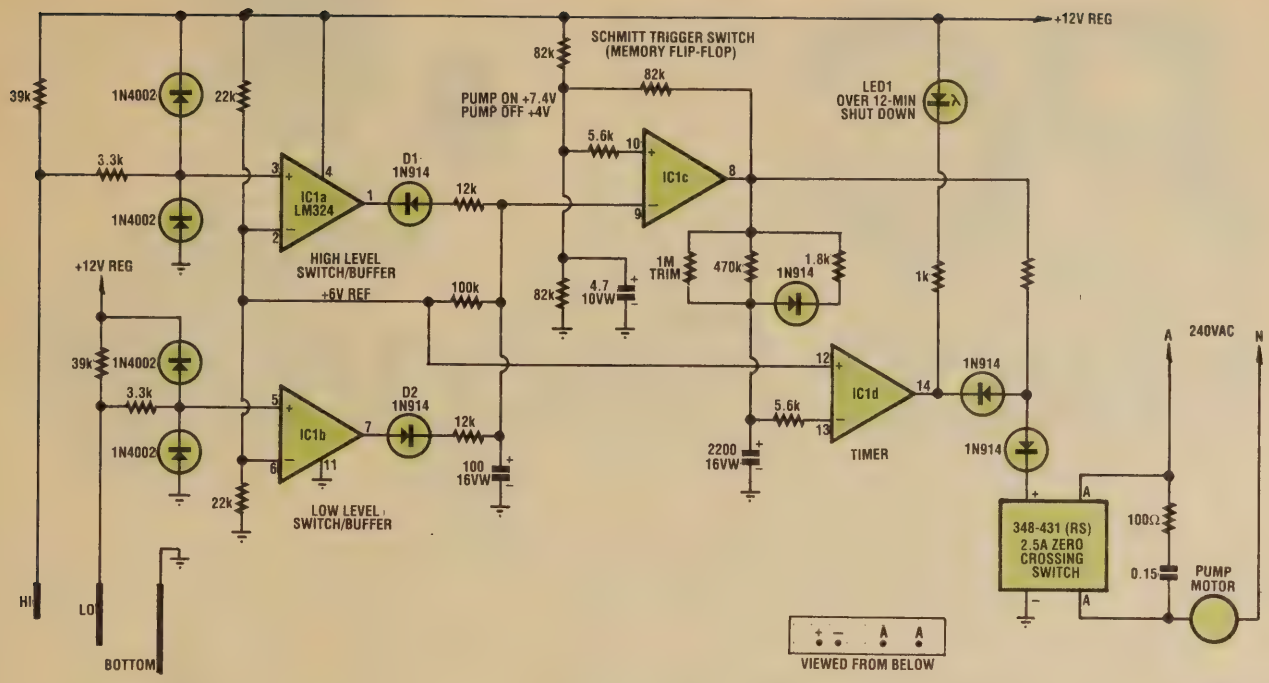
Furthermore, consider the case where no decimal points are required and the 74C926 is not being clocked. Latch outputs Q1, Q2 & Q3 will all be set high as all zeros would normally be displayed. With Q1-bar low, there is no overflow, so display 1 will blank out. With Q1 high, blanking of display 2 is enabled. As Q2-bar is high and DP2 is not required, pin 6 of IC3b goes high and so display 2 blanks out.

With pin 6 of IC3b high, display 3 blanking is enabled, via IC5c, as latch output Q3 is high. So all three leading digits are blanked when they would normally be showing zeros.

The circuit also caters for the situation where an over-range condition occurs and leading zeros would be displayed. In this case, the zeros are blanked but display 1 flashes alternately with the over-range LED because the over-range signal is gated through by XOR gate IC7a.

Also, the fourth decimal point (DP4) was added, driven via IC7b and IC7c.

G. Freeman,
Nairne, SA. ($40)



Automatic controller for sullage pumps

This automatic pump controller is based on an LM324 quad op amp IC.

Three aluminium rods (not anodised aluminium) are lowered into the holding tank. One rests on the base and the other two are set at the desired upper and lower levels for the water.

IC1a and IC1b are wired as comparators and these control Schmitt trigger stage IC1c via diodes D1 and D2.

Normally, pin 8 of IC1c is low and the pump is off. When the water rises and contacts the HI probe, pin 3 of IC1a is pulled low and so its pin 1 output also goes low.

This low pulls pin 9 of IC1c low. Thus, pin 8 of IC1c switches high and turns on the pump via the zero crossing switch. The pump now remains on until the water clears the LO probe. At this point, pin 5 of IC1b goes high and so its output at pin 7 pulls pin 9 of IC1c high via D2. Pin 8 of IC1c thus switches low again and the pump turns off.

Comparator stage IC1d automatically shuts the pump off if a preset time limit (about nine minutes) is exceeded, as set by the 1MΩ and 470kΩ resistors and the 2,200µF capacitor.

The zero crossing switch is available from Radiospares Components, Cat. 348-431.

The circuit could also easily be adapted to provide automatic replenishment of a water tank. This simply involves reversing the inputs to IC1a & IC1b, and reversing diodes D1 & D2 at the comparator outputs.

Glen Host,
Doubleview, WA. ($40)

Low distortion sinewave oscillator

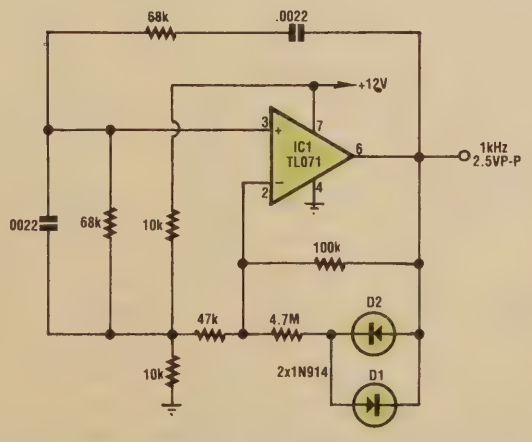
If you need to hook up a low-distortion sinewave oscillator in a hurry, then this circuit is about as simple as you can get. The design is a variation of the sinewave generator project featured in the February 1991 issue of SILICON CHIP.

The circuit is a Wien bridge style with the two .0022µF capacitors and the 68kΩ resistors setting the frequency to the formula $F = 1/2\pi RC$.

The 100kΩ and 47kΩ resistors, and the two 10kΩ resistors, set the overall gain to just above 3. This is just enough gain to start oscillation. Diodes D1 and D2, along with the 4.7MΩ resistor, provide a small amount of gain control to the circuit, to stabilise the amplitude at the output to about 2.5 volts peak-to-peak.

Using a TL071, the distortion was measured at 0.1%, but with more filtering it can quite easily be lowered further.

Darren Yates,
SILICON CHIP.



The circuit is based on a TL071 op amp (IC1) & is wired in Wien bridge configuration. It delivers about 2.5V p-p of signal with 0.1% distortion.

PC Voice Recorder

Enter the world of digitized speech with this low-cost PC Voice Recorder. It can record messages up to 20 seconds long, store them on hard or floppy disc, and then replay them when you wish.

By DARREN YATES

If you stop flying your F19 stealth fighter and think about it for a minute, the computer (any computer, not just a PC!) is the most useful gadget ever to fall into the lap of the electronics enthusiast.

Not only can you store your latest project on CAD, including the PC board, but you can also write it up and even design it on the computer using one of the various SPICE packages that are now available. And if you get stuck at some point, you can go flying your Spitfire and shoot down some ME-109s (that's known as executive stress management!).

The problem is, most of these packages (except for the games) cost an arm and a leg and are out of reach for most hobbyists.

If you look in many of the electronics and computing magazines, the latest trend is towards talking objects; things like talking voltmeters and talking clocks. There's even a new IC that's just been released in the US to which you connect a microphone, a battery and a loudspeaker, and it will record and replay 20 seconds of speech!

Not to be left behind in the race, we've come up with this low-cost PC Voice Recorder system. But unlike most other voice synthesiser projects, this design doesn't use any hard-to-get bits. In fact, you will probably already have most of the components lying in your spare parts bin.

Basically, the project comes in two parts: (1) a PC board assembly; and (2) a floppy disc with software (see panel). The PC board assembly provides the interface between the speech and your computer. It takes in speech, turns it into digital data which the computer can use, and then later accepts that digital data and turns it into speech again.

The software is used to control this process. It stores the data on either a hard or floppy disc, retrieves it when asked, and then feeds the digital data to the PC board so that it can be turned back into speech again.

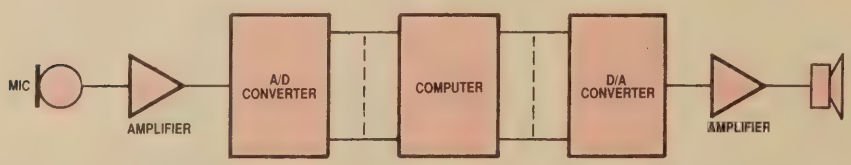


Fig.1: block diagram of the PC Voice Recorder. The incoming speech signal is picked up by a microphone, amplified, turned into digital data by an analog-to-digital converter (ADC), and stored in the computer. Retrieving the audio from the computer is just the reverse process. The digital data from the computer is simply turned back into an analog signal by a digital-to-analog converter (DAC), amplified and fed into the loudspeaker.

Block diagram

The basics of computer stored speech are shown in the block diagram of Fig.1.

The incoming speech (audio) signal is first turned into an electronic signal by the microphone and then amplified. This signal is then turned into digital data by an analog-to-digital converter (ADC) and the data fed into the computer.

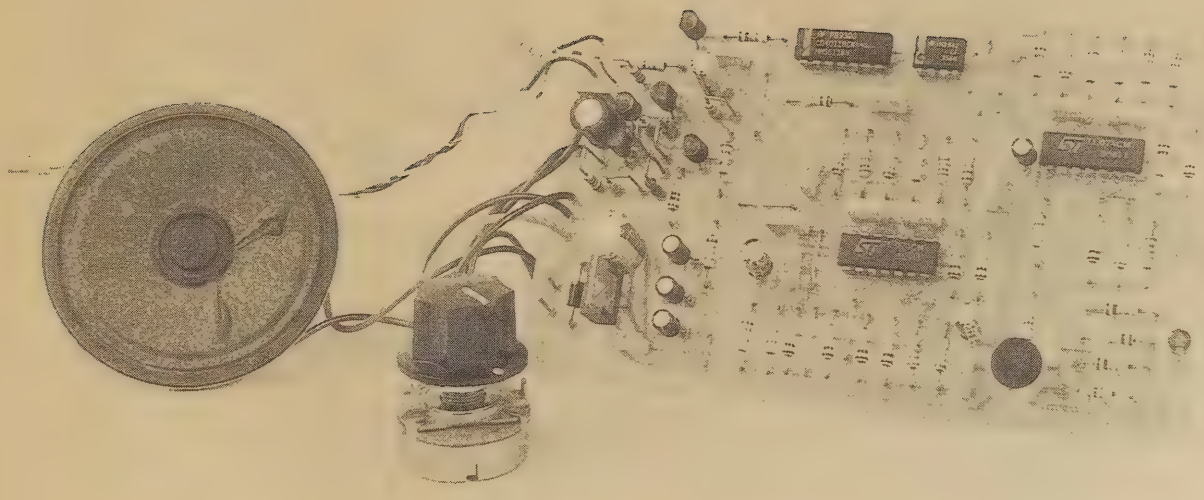
The computer, under the control of the software, can then process these signals (known as Digital Signal Processing or DSP) and store them for later retrieval.

Retrieving the audio from the computer is just the reverse process. The digital data from the computer is simply turned back into an analog signal by a digital-to-analog converter (DAC), amplified and finally fed into the loudspeaker for all to hear.

Computer limitations

Mind you, as versatile and useful as an XT or even an AT is, there are some very real practical limits that have to be considered before we can come up with a workable system.

Most of these limits revolve around the PC itself. First, we have to con-



All the parts except for the loudspeaker & the volume control pot are mounted on a small PC board. The unit plugs into the parallel printer port of the computer via a DB-25 connector.

sider how we are going to get the data into the computer.

Without worrying about expansion sockets and whatever, virtually all PCs come with a parallel printer socket and a serial communications socket. These sockets, at the back of the computer, provide easy access to these ports without the need for internal hardware modifications. We arbitrarily decided on the printer port.

Next, we have to consider how the computer is going to process and store the data we feed in.

To keep the whole project as simple yet as practical as possible, we limited it to using GWBASIC, which everyone has via MS-DOS. This allows everyone to use this project, whether you have a 256Kb XT built out of spare bits or a 16Mb 486 machine going slightly slower than daylight.

GWBASIC though is pretty slow and just isn't fast enough on its own to do the job, so we used assembly language for all the really fast bits such as receiving and transmitting data. Storing the data is actually quite easy and is quick - even using GWBASIC. It's simply saved as a binary file on either hard or floppy disc.

The next can of worms we have to open is how to turn the analog signal into a digital signal and back again.

If you're a bit sketchy on how analog-digital-analog conversion works, then take a look at the article on this subject in next month's issue of SILICON CHIP.

The powers-that-be limited GWBASIC to 64Kb of memory, which leaves us with about 59Kb of free memory by the time we get to use it. However, to allow you to expand the software to suit your own requirements, we've limited the data storage for the speech to 32Kb bytes.

And that's where we strike problems. If we use standard A/D techniques, an 8-bit converter will soon chew up the limited memory we have to play with.

Even if we limit the frequency response to 3kHz, we would have to sample the audio at an 8kHz rate at least to overcome aliasing problems. Briefly, aliasing is the effect heard when the audio mixes with the sampling frequency to produce audible "errors" in the signal.

But sampling at 8kHz gives us just 32/8 = 4 seconds of storage - and that's nowhere near enough!

Not only that, but the parallel printer socket doesn't have an 8-bit input port anyway!

Delta-sigma modulation

The alternative sampling method used here is not widely known and is called Delta-Sigma Modulation or DSM. The name comes from the Greek letters "Delta" (the symbol used for the mathematical process called differentiation) and "Sigma" (the symbol used to denote integration).

The advantage of this system is that it only has a 1-bit output stream, yet it contains enough information to reproduce speech.

Fig.2 shows the circuit of an ADC based on a simple differentiator. It consists of an op amp, a resistor and a capacitor. Let's see how it works.

If we assume the circuit has just been switched on, then there will be

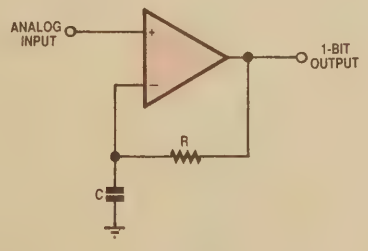


Fig.2: basic op amp differentiator circuit. This circuit is used for analog to digital conversion in the PC Voice Recorder.

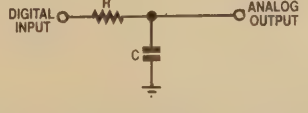


Fig.3: this integrator (or low-pass filter) circuit is used for the reverse digital to analog to digital conversion.

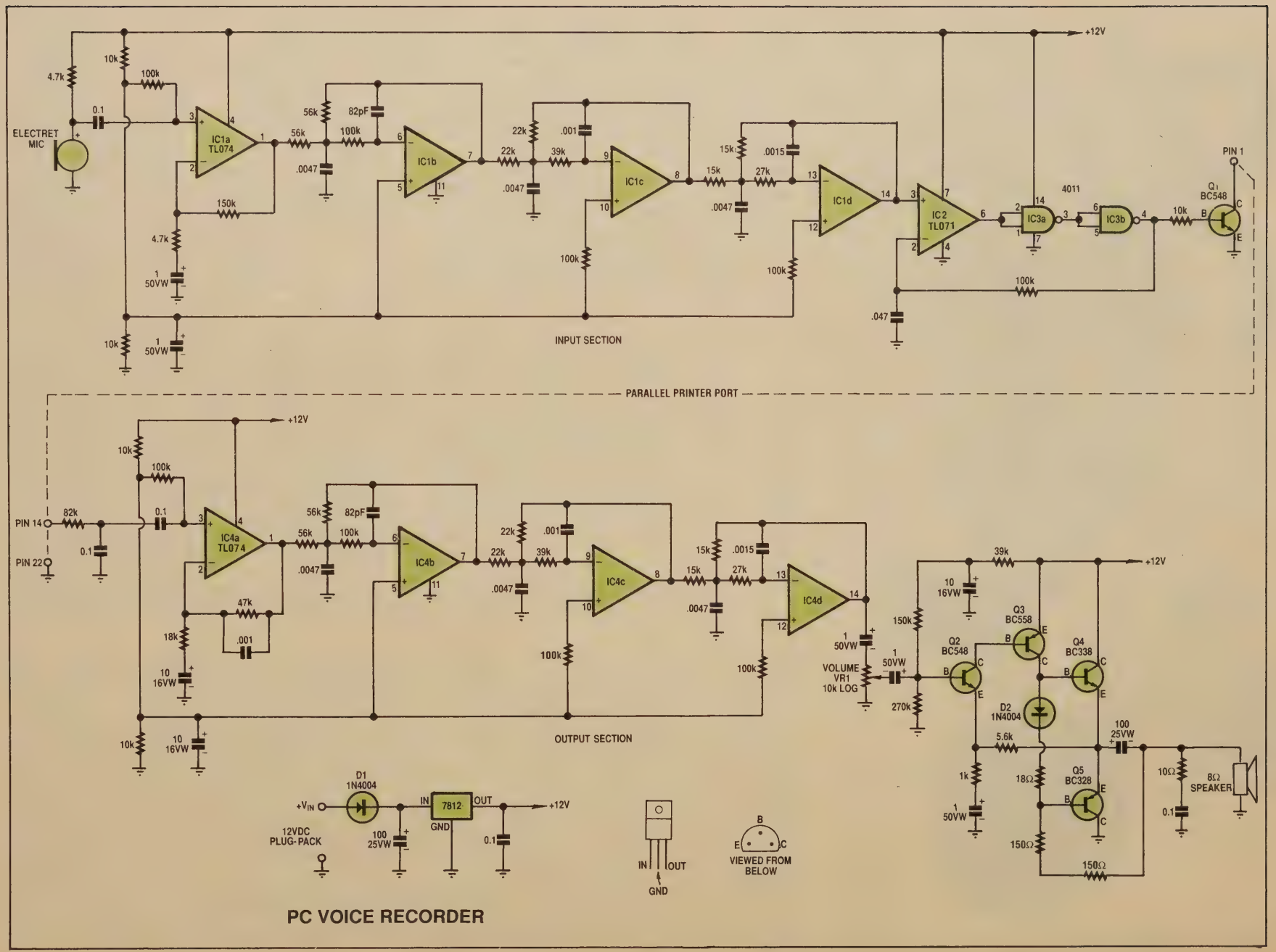

+12V
ELECTRET MIC
IC1a TL074
IC1b
IC1c
IC1d
IC2 TL071
IC3a
IC3b
4011
PIN 1
Q1 BC548
INPUT SECTION
PARALLEL PRINTER PORT
PIN 14
PIN 22
IC4a TL074
IC4b
IC4c
IC4d
OUTPUT SECTION
VOLUME VR1 10k LOG
Q2 BC548
Q3 BC558
Q4 BC338
Q5 BC328
D2 1N4004
8Ω SPEAKER
D1 1N4004
+VIN
12VDC PLUG-PACK
7812
IN
OUT
GND
VIEWED FROM BELOW
PC VOICE RECORDER

Fig.4 (left): the complete circuit diagram for the PC Voice Recorder. The signals picked up by the microphone are amplified by IC1 & fed to a 6th order low-pass Butterworth filter (IC1b, IC1c & IC1d). This filter stage then drives an analog-to-digital converter based on IC2, IC3a, IC3b & Q1. On playback, the data from the computer is fed to an integrator, amplified & filtered by IC4a-d, & then fed to audio amplifier stage Q2-Q5.

no voltage across the capacitor. If we now apply an analog voltage to the non-inverting input, it will be higher than the inverting input and so the output of the op amp goes high (ie, the op amp behaves as a comparator). This high then charges capacitor C via resistor R, with a time constant of RC.

This continues until the voltage across the capacitor is higher than the incoming voltage, at which point the output of the op amp goes low. This now discharges the capacitor through resistor R until the input voltage is higher than that across the capacitor. The output of the op amp then switches high again and so the cycle is repeated indefinitely.

You could also call this circuit a slope detector, because it detects the slope of the input voltage; ie, if the input voltage is rising, the comparator output will be high. Conversely, if the input voltage is falling, the output will be low.

Notice we have not said anything about exact voltage values. In fact, there is enough information contained in this single bit output for us to be able to store it on disc (via the parallel printer port), retrieve it, and convert it back into recognisable speech.

To turn the digital data back into speech, we do the reverse mathematical process, which is known as integration. The basic circuit is shown in Fig.3. If you think that it looks remarkably like a low-pass filter, you are absolutely correct.

A low-pass filter works perfectly as an integrator because the charging and discharging action on the capacitor replaces the slopes that were removed in the original conversion. So this simple low-pass filter is all we need to perform digital to analog conversion. In fact, if you look back at the ADC section (Fig.2), you'll see that we had a similar low-pass filter in the negative feedback loop of the comparator.

The circuit

Refer now to Fig.4 which shows the complete circuit diagram of the PC Voice Recorder. It can be split into two sections: the input section which converts the speech into the 1-bit data stream; and the output section which converts this bit stream back into speech.

Starting at the input, the speech is converted into electrical signals by an electret microphone and then amplified approximately 34 times by non-inverting amplifier IC1a (which is part of a TL074 quad op amp). IC1a's output is then fed into a 6th order low-pass Butterworth filter with a 3dB cutoff frequency of 3kHz (IC1b, IC1c & IC1d).

The idea here is to block the upper frequencies which can cause aliasing problems at the 18kHz clock frequency.

The 6th order low-pass filter actually consists of three cascaded 2nd order stages formed by IC1b, IC1c & IC1d. The non-inverting inputs of these stages are all biased to half supply (1/2Vcc) via a voltage divider consisting of two 10kΩ resistors, which is also used to bias IC1a. With the exception of IC1b, this bias voltage is fed to each op amp via a 100kΩ resistor.

The output of the 6th order filter appears at pin 14 of IC1d and is fed to pin 3 of op amp IC2, a TL071. This, along with NAND gates IC3a and IC3b, forms the delta ADC; ie, it behaves as a differentiator. IC3a & IC3b form a CMOS buffer which ensures that the output of the ADC swings to both ends of the supply rail.

Note that because of its tracking nature, the delta ADC also oscillates at about 18kHz. This 18kHz oscillation is later filtered out by a 6th order filter section in the output stage.

The output of the converter appears at pin 4 of IC3b and is fed to NPN pull-down transistor Q1, which is connected to pin 1 of the parallel printer port. This is the -STROBE line.

This simple transistor interface can be used because those pins designated as port C on the printer port have 4.7kΩ pull-up resistors. Thus, we can input data without worrying about keeping to the "5V rule" of the port.

As mentioned earlier, the reverse process is used to turn the digital data back into speech. The output from the computer is taken from pin 14 of the printer port; ie, from the -AUTO FEED

PARTS LIST

1 PC board, code SC07107911, 132 x 82mm
1 floppy disc containing PCVOICE software (see panel)
1 DB25 male printer port plug
1 8Ω mini loudspeaker
1 12V DC 300mA plugpack
1 electret microphone insert
1 10kΩ log potentiometer (VR1)

Semiconductors
2 TL074 quad op amps (IC1,IC4)
1 TL071 op amp (IC2)
1 4011 quad 2-input NAND gate (IC3)
3 BC548 NPN transistors (Q1,Q2,Q4)
2 BC558 PNP transistors (Q3,Q5)
2 1N4004 rectifier diodes (D1,D2)

Capacitors
2 100µF 25VW electrolytics
3 10µF 16VW electrolytics
5 1µF 50VW electrolytics
5 0.1µF 63VW 5mm-pitch polyester
1 .047µF 63VW 5mm-pitch polyester
6 .0047µF 63VW 5mm-pitch polyester
2 .0015µF 63VW 5mm-pitch polyester
3 .001µF 63VW 5mm-pitch polyester
2 82pF 5mm-pitch ceramic

Resistors (5%, 0.25W)

1 270kΩ	1 18kΩ
2 150kΩ	4 15kΩ
9 100kΩ	4 10kΩ
1 82kΩ	1 5.6kΩ
4 56kΩ	1 4.7kΩ
1 47kΩ	1 1kΩ
3 39kΩ	2 150Ω
2 27kΩ	1 18Ω
4 22kΩ	1 10Ω

Miscellaneous
Hookup wire, solder, zippy box (optional), ribbon cable etc.

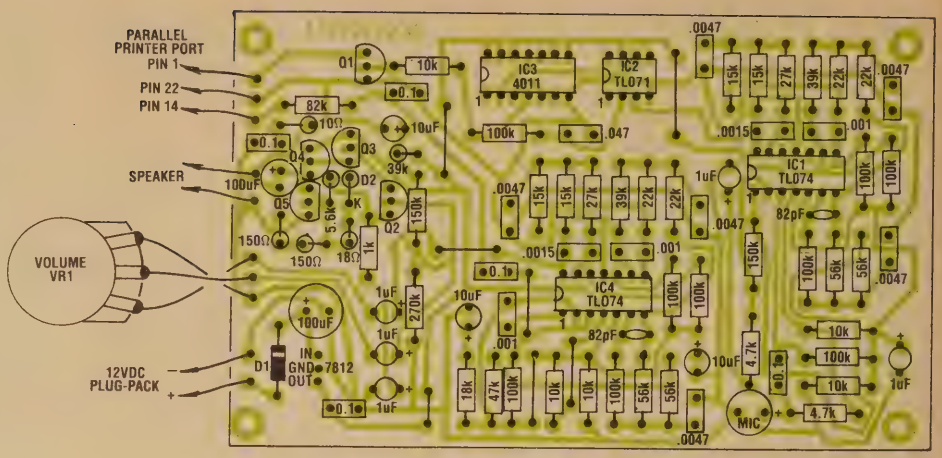


Fig.5: follow this wiring diagram carefully when installing the parts on the PC board & take care with component orientation. The circuit diagram (Fig.4) shows the pinout details for the transistors & 3-terminal regulators.

line. One of the normal data out lines could have been used but this would have necessitated switching the port addresses.

The digital bitstream is then fed into an 82kΩ resistor and two 0.1µF capacitors, which together form the integrator. The signal is then amplified by a bandpass filter stage IC4a which has a gain of 3.6 and a frequency response of 1Hz-3.3kHz, as set by the associated 10µF and .001µF feedback capacitors.

The output from IC4a at pin 1 is then fed into another 6th order low-pass Butterworth filter (IC4b-IC4d), which is an exact copy of the circuit used in the input stage. As before, the filter is DC-coupled throughout and the non-inverting inputs are all biased to 1/2Vcc. The output appears at pin 14 of IC4d and is coupled to an audio amplifier via a 1µF capacitor and volume control VR1.

Transistors Q2-Q5 form a fairly standard class AB audio amplifier circuit. DC bias for Q2 is provided by the 150kΩ and 270kΩ resistors on its base, while the 5.6kΩ and 1kΩ feedback resistors (at Q2's emitter) set the overall gain of the amplifier to 5.6. The 1µF capacitor rolls off the response below 150Hz.

Q2 is wired as a common emitter amplifier and also provides much of the voltage gain. Its collector output drives the base of Q3 which functions as a driver stage for complementary output pair Q4 & Q5. These transistors in turn provide the necessary current gain to drive the loudspeaker.

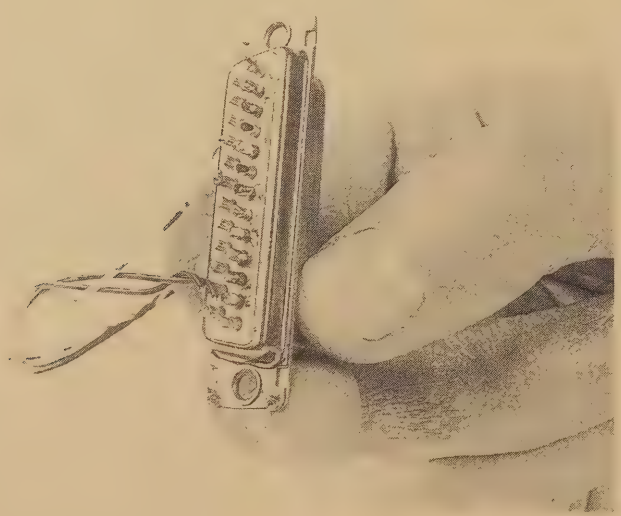
Note that the bottom end of Q5's 300Ω (2 x 150Ω) base bias resistor has been connected to the output rather than to ground. Because Q5 functions as an emitter follower, its voltage gain is almost unity and so there is almost no AC signal voltage across the two 150Ω resistors. This means that very little signal current flows in these two resistors and so the impedance of the bias network appears to be much higher than it really is.

This technique is known as "bootstrapping" and results in greater signal output with lower distortion.

D2 and its associated 18Ω resistor provide some forward bias to the output pair under no-signal conditions to minimise crossover distortion. Finally, a Zobel network consisting of a 10Ω resistor and 0.1µF capacitor has been connected across the output to ensure amplifier stability.

Power for the circuit is derived from a 12V DC plugpack supply. This delivers about 17V when lightly loaded and is fed to a 7812 3-terminal regulator via reverse polarity protection diode D1.

The resulting +12V rail from the 7812 is then used to power the various circuit stages.



The voice recorder board is plugged into the parallel printer port of the PC via a 3-wire cable & a standard DB-25 connector. Try to keep the cable length to less than two metres.

Software

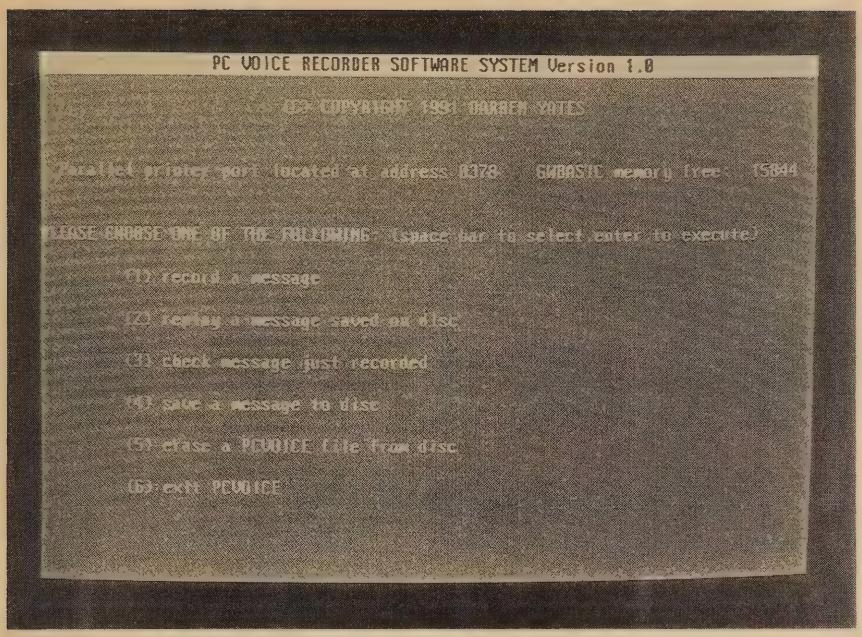
Once you have obtained your copy of the software, you will need to load your copy of GWBASIC onto the disc. If you have a hard disc, simply get into your DOS directory and type:

COPY GWBASIC.EXE A:<enter>

When the file has been copied, type A:<enter> to go back to your floppy disc drive, then type GO<enter>.

This will automatically load in and run PCVOICE. Once it is running, you will see a menu on-screen asking you to designate the drive in which you wish to load and store your PCVOICE files. You have the choice of either the A, B or C drive. If you select either the A or B drives, PCVOICE will automatically store them in the main directory.

However, if you choose the C drive,


PC VOICE RECORDER SOFTWARE SYSTEM Version 1.0
(C) COPYRIGHT 1991 DARREN YATES
Parallel printer port located at address 0378 GWBASIC memory free 15844
PLEASE CHOOSE ONE OF THE FOLLOWING (space bar to select,enter to execute)
(1) record a message
(2) replay a message saved on disc
(3) check message just recorded
(4) save a message to disc
(5) erase a PCVOICE file from disc
(6) exit PCVOICE

This photograph shows the menu screen of the PCVOICE software package. You can select different options by pressing the spacebar & then pressing the enter key when the option you want has been highlighted.

PCVOICE will store the files in a subdirectory called C:\PCVOICE.

Once you have made your choice by typing in the letter and pressing <enter>, you will see a new menu which asks you to choose one of six options:

(1) record a message;

(2) load & replay a message from the specified disc drive;

(3) replay the message just recorded;

(4) save the message in memory to the specified disc drive;

(5) erase an existing PCVOICE file from the specified disc drive; and

(6) quit PCVOICE.

To select one of the options, first press the spacebar. A solid white bar will show up on the screen over the first option but you can select any of the other options simply by further pressing the spacebar. When the bar is over the option you wish to select, press <enter>.

The software copyright is retained by the author but for those who wish to experiment further, remarks are included on the operation of the assembly language subroutines.

Construction

Virtually all the parts for the PC Voice are mounted on a single PC board. This board carries the code number SC07107911 and measures 132 x 82mm. Fig.5 shows the wiring details.

Start construction by soldering in PC stakes at the external wiring points, followed by the seven wire links. This

CAPACITOR CODES

Value	IEC Code	EIA Code
0.1µF	100n	104
.047µF	47n	473
.0047µF	4n7	472
.0015µF	1n5	152
.001µF	1n	102
82pF	82p	82

RESISTOR COLOUR CODES

No.	Value	4-Band Code (5%)	5-Band Code (1%)
1	270kΩ	red violet yellow gold	red violet black orange brown
2	150kΩ	brown green yellow gold	brown green black orange brown
9	100kΩ	brown black yellow gold	brown black black orange brown
1	82kΩ	grey red orange gold	grey red black red brown
4	56kΩ	green blue orange gold	green blue black red brown
1	47kΩ	yellow violet orange gold	yellow violet black red brown
3	39kΩ	orange white orange gold	orange white black red brown
2	27kΩ	red violet orange gold	red violet black red brown
4	22kΩ	red red orange gold	red red black red brown
1	18kΩ	brown grey orange gold	brown grey black red brown
4	15kΩ	brown green orange gold	brown green black red brown
4	10kΩ	brown black orange gold	brown black black red brown
1	5.6kΩ	green blue red gold	green blue black brown brown
1	4.7kΩ	yellow violet red gold	yellow violet black brown brown
1	1kΩ	brown black red gold	brown black black brown brown
2	150Ω	brown green brown gold	brown green black black brown
1	18Ω	brown grey black gold	brown grey black gold brown
1	10Ω	brown black black gold	brown black black gold brown

Where To Buy The Software

The software for this project is only available direct from the author, Darren Yates. The software for the PCVOICE recorder, PCVOICE.BAS, is priced at $25 plus $3 p&p, and includes running instructions and all assembly language routines. The TIME.BAS talking clock software is priced at $15 plus $3 p&p.

All software comes on a single 360Kb 5 1/4-inch floppy disc and will run on any PC with 256Kb of RAM and a printer port. Payment should be made by cheque or postal money order to: Darren Yates, PO Box 134, French's Forest, NSW 2086.

Note: Copyright of the software is retained by the author.

done, install the resistors. Most of these lay flat on the board, except for those around the output amplifier area which are mounted end-on to save space.

Check each resistor on your DMM before installing it on the board, to make sure you have the correct value.

Next, solder in the 5mm fixed-pitch capacitors. Check their values carefully against the wiring diagram as they all look the same and are easy to mix up. The electrolytics can now be installed but make sure that they all go in the right way around.

Now for the semiconductors. Once again, you must make sure that they are all correctly oriented. In particular, take care with the orientation of the transistors in the audio amplifier stage. Fig.4 shows their pinout details. Mount the 3-terminal regulator with its metal tab away from D1.

Once all the parts have been installed, connect the volume pot (VR1), microphone insert and 8Ω loudspeaker to the board using suitable lengths of hookup wire. Finally, connect a 3-wire cable between the DATA IN, DATA OUT & GND pins on the PC board and pins 1, 14 & 22 respectively of a DB-25 printer plug.

It's a good idea to use different coloured leads for these connections if you intend making up a long cable run, as this makes the leads easier to sort out. We used a 2-metre long cable with the prototype, with no obvious effect on circuit operation.

We left our board in the "barebones" state but you can mount your version in a plastic zippy case, or some other suitable case. The volume control can be mounted on the front panel along with the loudspeaker. Don't forget to drill a number of holes in front of the loudspeaker to allow the sound to escape (but don't do this with the loudspeaker in position).

Testing

Once you have finished construction, check the PC board carefully for solder splashes and missed solder joints. Check also that the correct part has been installed at each location and that all parts are correctly oriented.

When you're satisfied that everything is OK apply power but don't hook the unit up to your computer just yet. If you have a CRO handy, take a look at the output (pin 4) of IC3b. You should get a squarewave of 12V amplitude at about 18kHz or so.

If you don't have a CRO, use a frequency meter to check that pin 4 of IC3b is oscillating at about 18kHz. This frequency is not overly critical however, and can be anywhere in the region of 16-25kHz. If you don't have a frequency meter either, use your DMM to check that the output of the regulator is at +12V and that pin 4 of IC3b sits at an average voltage of about 6V under no-signal conditions.

Applications

So what can the unit be used for? Well, if you write your own software, you can incorporate this project to give your programs the added glory of speech. For example, we wrote a program called TIME.BAS (see panel), which turns the PCVOICE board into a talking clock. It's similar to the talking clock service provided by Telecom, although the voice on our unit is nowhere near as refined.

Other possible applications are to use the unit as a household message machine, as a sales gimmick or just for experiment. It's limited only by your imagination. SC

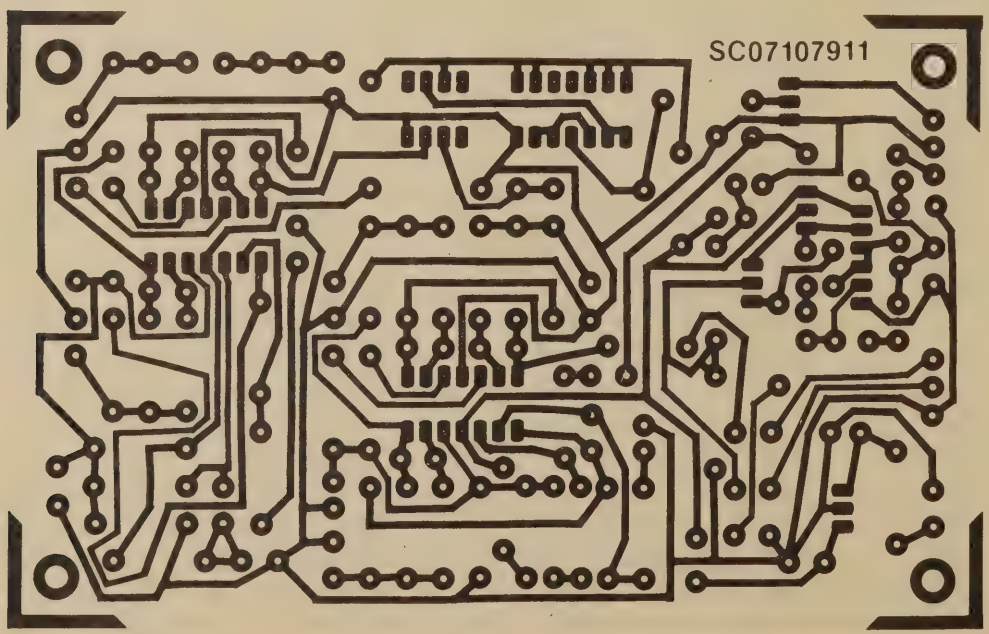


Fig.6: use this full-size pattern to make your own PC board or to check that a commercially made board has been correctly etched.

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15V CT @ 150mA 2VA

240V primary, solder lugs. Size same as 2851 types
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$5.95

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Top quality US made 240V 50Hz 1300rpm motor which was used to power a cylindrical blower fan for an air conditioning system. Taiwan made motors sell for around $40 - US made motors would cost $60 or more plus tax.
We have a limited quantity.
Dimensions 85 dia, 100 height including mounting bolts and drive shaft.
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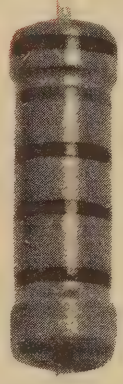
THE *ULTIMATE* RESISTOR PACK

That's exactly what this pack is - The Ultimate
This pack gives you every resistor in the E48 range from 0.5 ohm to 9.1 Meg. The E48 range goes like this:
10, 11,12, 13, 15, 16, 18, 20, 22, 24, 27, 20, 33, 36, 39, 43, 47, 51, etc
So, you get 10 of every value, a total of 170 values, 1700 resistors in all and they are bandoleered for easy sorting.
The resistors!
They are top quality, guaranteed 1/4 watt 5% miniature sized. In fact they look like 1/8W they are so small.
Buy this pack and you will NEVER be short of any resistor again.
To buy all these resistors on an individual basis (i.e. 5¢ ea) it would cost you $85.
This pack costs well under 1/2 that price and there is a limited quantity.
Cat. RR-2000
ONLY $29.95
Less than 2¢ ea



NEW

ELECTRONIC PIEZO PUSH BIKE HORN

This quality Italian piezo push bike horn will really alert motorists that you are nearby. Easily attaches to handlebars, it emits a piercing scream. Requires a 9V 216 type battery. To import these today from Italy would cost a fortune.
Limited quantity.
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This 12 volt motor driven siren really let out a blast! In fact, it's almost deafening. It's very small compared to most sirens measuring only 82(H) x 80(L) x 74(D)mm. Limited quantity.
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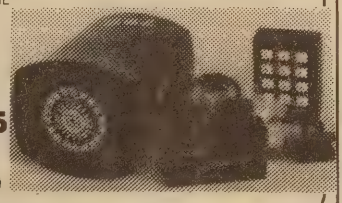
Ranger 752 is a top quality European made car burglar alarm. We have purchased the entire stock of this model and can offer them at a fraction of their normal price.
The electronics are housed in a die cast metal box (not plastic) and it has a master bypass switch in the siren. It also includes battery back-up which continues to power the alarm if the battery is disconnected. The alarm is supplied with two different arm/disarm systems, you can choose which one you want to use. One is a pushbutton keypad and the other is called an electronic key, which requires a pushbutton to be activated for arm - and a key inserted for disarm.
FEATURES INCLUDE:
• Battery backup • Engine kill • Current sensing • Flashing indicators • Adjustable inbuilt shock sensor • Adjustable inbuilt window break sensor • Internal screamer can be used
Supplied with instructions, lug connectors, keys, mounting bracket and mounting screws.
Optional accessories - ultrasonic sensor Cat. LA-8960 $39.95, internal screamer (Tweety Pie) Cat. LA-5255 $17.95
SAVE A FORTUNE OVER NORMAL PRICE
Cat. LA-8955
ONLY $49.95



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Last year we were forced to increase our prices on 3 and 4mm nuts and bolts because the local importer we bought from increased their prices. We really weren't happy about this, so we've been on the lookout for a new supplier, which we have found. We can now REDUCE our everyday prices back to somewhere near where they were last year.

Description	Qty	Cat	Old Price	New
3x6mm screw	25	HP0400	$1.20	$1.00
3x6mm screw	200	HP0401	$4.20	$3.50
3x10mm screw	25	HP0403	$1.20	$1.00
3x10mm screw	200	HP0404	$4.75	$3.75
3x15mm screw	25	HP0406	$1.30	$1.10
3x15mm screw	200	HP0407	$4.95	$3.95
3x20mm screw	25	HP0410	$1.40	$1.20
3x20mm screw	200	HP0411	$6.20	$4.95
3x25mm screw	25	HP0414	$1.50	$1.25
3x25mm screw	200	HP0415	$7.50	$5.95
3x32mm screw	25	HP0418	$1.60	$1.50
3x32mm screw	200	HP0419	$8.95	$7.50
Flat washer	25	HP0430	$1.25	$1.00
Flat washer	200	HP0431	$4.75	$3.50
Shake washer	25	HP0433	$1.40	$1.20
Shake washer	200	HP0434	$7.50	$5.95
3mm nut	25	HP0425	$1.50	$1.20
3mm nut	200	HP0426	$7.25	$4.95
4x10mm screw	25	HP0450	$1.40	$1.30
4x10mm screw	200	HP0451	$7.20	$6.50
4x15mm screw	25	HP0453	$1.50	$1.40
4x15mm screw	200	HP0454	$7.95	$6.95

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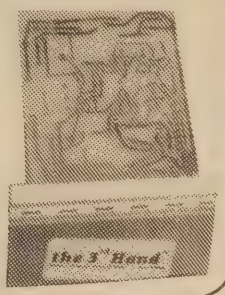
The 3rd hand is a top quality tool ideal for the hobbyist and professional. It's a PC board holder which attaches to a desk via a non scratch clamp. Once this is done the PC board is simply inserted and will rest in a position that is ideal for soldering. To insert more components the board simply flips forward, then back to its original position for soldering them in. Made in the USA. Limited stock.
Cat. TH-1980
ONLY $16.95



ELECTRONIC TOOLBOXES!

Jaycar proudly announce two new quality plastic toolboxes to our range.
Two sizes are available, medium and large and both are ideal not only for hobbyists, but anyone who needs to carry and care for tools.

SMALL SIZE

Has two fold-out trays to store small components/parts and room in the bottom for tools.
Size: 320(L) x 140(H) x 160(D)mm.
Tray size: 290(L) x 130(W) x 25(D)mm
Includes carry handle and locking clip.
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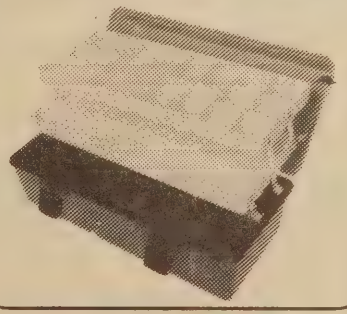
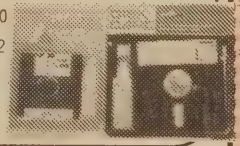
Ideal for the professional or tradesperson. Has two fold-out trays with adjustable compartment dividers, twin locking clips and twin carry handle
Size 415(L) x 160(H) x 170(D)mm
Tray size: 375(L) x 155(W) x 28(D)mm
Cat. HB-6332
$24.95



DISK DRIVE CLEANERS

With these cleaners you can keep your drives in top shape and save your diskettes from damage.
3 1/2" KIT Cat. XC-4790
5 1/4" KIT Cat. XC-4792
$6.95 ea

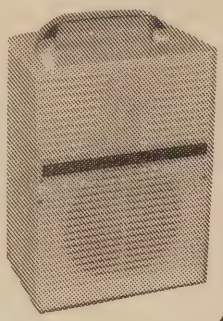


JAYCAR ELECTRONICS

ELECTRONIC WATCHDOG

NEW

IF you are aged or live on your own, owning a dog can offer you wonderful peace of mind, especially at night from the risk of intruders. There are so many problems associated with owning a dog - feeding it, caring for it, walking it, vet bills, who looks after it on holidays etc.
This product can offer you peace of mind at night without all the fuss associated with dog ownership.
The electronic watchdog incorporates a microwave motion sensor which activates when it detects movement and then it starts barking. It bark for 5 seconds each time it is triggered and barks continually if there is constant movement. The sound is very authentic and would easily scare the wits out of an intruder.
The unit is housd in a plastic box with a handle on the top. It operates form 240V through a plugpack (supplied) and has a volume control and a range of control.
Call into any store for a demo.
Cat LA-5280



$129.50

ECONOMY WIRELESS SECURITY SYSTEM

At last, you can now install your own wireless burglar alarm and it won't cost you and arm and a leg!
The new EG100 is made by Zeus, the same people who make our current wireless system. In fact, all the same wireless extras will work with this panel. The EG100 is a key operated single sector panel which accepts not only the wireless PIR's etc, but you can hard wire detectors as well. For example 2-wireless PIR's, 2 wireless door/window transmitters and a wired PIR will all work very happily on the one sector.
This is the lowest priced wireless panel we've seen that is TOP QUALITY. There are plenty of junky ones around that we just won't sell. After all - a burglar alarm that false triggers is no good to anyone!
FEATURES
• Low cost • DIY installation • Accepts wireless and wired sensors • Tamper proof protected • LED indicators • Keyswitch arming with exit delay time • Instant alarm when sensors triggered • NC and NO relay output
SPECIFICATIONS
• Operates on 303-875MHz • System codes 4,096 • Transmitting range 50 metres (open space) • 30 second exit delay • instant entry delay
Accessories
• Back up battery 1.2A 12V Cat. SB-2480 $26.50 • Wireless passive infra red detector Cat. LA-5205 $129.95 • Door/window reed switch Cat. LA-5210 $69 • Siren 12V DC Cat. LA-5700 $28.50 • Strobe light Cat. LA-5300 $32.95 • Wired PIR's from $59.
Cat. LA-5202
Includes 240V power supply

NEW

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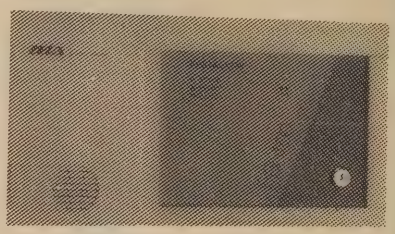


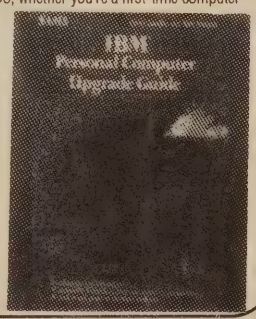
ALARM CONTROL PANEL BOX

We have a quantity of super high quality alarm control boxes. They are painted cream and have various holes in the panel for LEDs, cam lock, etc. Some have the front panel printed, some don't, the holes vary and the size of the panels vary. The size of the sample is 330(H) x 230(W) x 85(D)mm, but some are slightly smaller than this.
This product is more suited to the personal shopper who can pick the one most suited, however, we will ship to mail order customers upon request. (Cam lock Cat SM-1029 $8.95. Locking arm may not be correct length in some cases.) Ideal for hobbyists and installers. Save a bundle.
Cat HB-5480

ONLY
$24.95 ea

IBM PERSONAL COMPUTER UPGRADE GUIDE

By C Sandler and T Badgett
Packed with upgrade package hits, misses and preferences, you get expert advice on what to do with your PC. With all the information this handy text contains, you can even build your own custom design piece-by-piece!
This book is an invaluable resource on: • Upgrading advantages and disadvantages • Selecting hard disk drives and their components • Completing a computer "makeover" • Operating system upgrades • Printers and their options • Testing your upgrade system • Plus much more!
And it's all in a "straight-talking", conversational text that's easy to understand. So, whether you're a first-time computer buyer or a veteran computer technician, you'll find this one of the most helpful books around.
285 pages, softcover, 190 x 230mm
Cat. BS-0740



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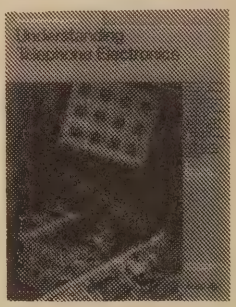
NEW

UNDERSTANDING TELEPHONE ELECTRONICS

By J Fike & G Friend
Electronics is bringing lower costs and expanded capabilities to telephone communications. This book tells you how. Subjects covered include: dialling, ringing, transmission, signalling, switching, digital techniques, modems and the new cordless phone technology. It's all here in an easy-to-understand format, fully illustrated and ideal for self-paced learning.
284 pages, softcover 180 x 230mm
Cat. BS-0460



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NEW

2 PIN MAINS LEAD

This lead has a 2 pin Australian plug on one end and a 1.8m cable (black) to bare ends. Qualily Burton brand, SAA approved. Limited quantlity.
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5 volt Cat. SY-4030 **$4.25**
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LOWER PRICES

THERMAL FUSES

As used in many 240 volt applications, e.g. hairdryers, heaters, hot rollers, irons etc.

128°C	Cat. ST-3804	**$2.50**
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NEW

SPADE LUG MADNESS

Stock up now. This bargain won't last long. Standard QC - 6.3mm spade lugs.
50 MALE, 50 FEMALE, 50 PLASTIC COVERS
Cal. PT-4510 **$8.95**

4-CHANNEL LIGHTING DESK KIT

Refer Silicon Chip June 1991
This 4-channel lighting desk is intended for theatre, disco and music group applications. It has heavy duty circuitry and is able to cope with spotlights rated up to 1000 watts or more.
Operating features

NEW

• Four channels • 60mm slider pots • Click action flash switches with integral LEDs
• Separate dimming for each channel • Master dimmer control • Flash on each channel
• Master dimmer for flash • 4-channel chaser • Adjustable chaser rate • Single step for chaser • Chaser on and off
• Flash switch LEDs mimic lamp display
The Jaycar kit includes pre punched and silk screen case, original C and K switches, original slider pots (Jaycar supplied the samples to Silicon Chip) and all specified components. Beware of kits with non original parts.
Cat. KC-5096

$329

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NEW BOOKS FROM JAYCAR

150 CIRCUITS

Ideal for the experimenter. Chapter headings include: audio, music and disco, indicators and alarms, switches, sequences and timing, house and home, power supplies, power control, radio, test gear, games, clocks and oscillators, photography, miscellaneous and design notes. Not only are there circuit diagrams, there is advice on building each circuit. An excellent book for the hobbyist. 98 pages, 220 x 275mm, soft cover.

Cat BM-2443 **$11.95**

SIMPLE ELECTRONIC EXPERIMENTS

This book describes 17 projects to build with full notes and schematic diagrams. Projects include cine slide synchronisation, electronic harmonium, Electronic automation unit for fire extinguishers, electronic winking eyes, intruder monitor, mini charger, electroplating machine, automatic street lights, electro combination lock. traffic control unit, Hi Fi booster, power alarm, plus more. 60 pages, 135 x 210mm. Cat BM-2444 **$4.95**

ELECTRONIC HOBBY CIRCUITS

This book describes 20 projects to build including - ultra sensitive temperature sensor, frequency divider, constant volume output, sound effects, transistor gain evaluator, IC signal injector, save on power, digital recording, the brainy door, static circuit breaker, Heads and tails, party blinker, electronic eye, DC-DC inverter, reflex tester, increase guitar output, automatic staircase light and more. 40 pages, 135 x 210mm.

Cat. BM-2445 **$4.95**

103 PROJECTS USING LEDS

If you enjoy using LEDs, you need this book. 103 different projects to build. Chapters are LEDs as pilot lamps (10 projects), Test Eq using LEDs (12), LED Indicators (10), Voltage monitors (7), Logic elements (7), OPTO projects (10), Displays (5), Games (10) Miscellaneous (12). 168 page, 135 x 210mm.

Cat BM-2446 **$12.95**

121 ELECTRONIC PROJECTS

Includes 20 passive projects - audio squelch, tape dubbing filter, tweeter crossover, wall meter and more and 101 low cost projects including - FM wireless mic, scream generator, electronic touch alarm, speech clipper, blackout alarm, mini light blinker, etc. All projects give a parts list, schematic and brief introduction. 66 pages 135 x 210mm.

Cat BM-2447 **$6.95**

SIMPLE AUDIO PROJECTS

This book describes how to build 20 projects including one and two transistor preamp, FET preamp, tape preamp, 50mW and 200mW amplifier, sine wave audio oscillator and guitar preamp, intercom, add on tone control, waa waa unit, audio limiter, recording level indicator, plus more, 33 pages, 135 x 210mm.

Cat BM-2448 **$4.95**

PRACTICAL AUDIO VISUAL PROJECTS

20 projects in this book including - stereo vision, quadraphonic sound system, telephone amp, 3 transistor signal generator, motor boat, commercial killer, siren, play worn out records, bass booster, headphone adaptor, simple amp, Hi Fi power amp, pre amp plus more. 46 pages, 135 x 210mm.

Cat BM-2449 **$4.95**

LEARNING BY EXPERIMENTS CMOS INTEGRATED CIRCUITS

This book presumes the reader has a prior knowledge of basic binary and TTL circuits. It discusses the CD4000 series ICs in a simple and non-mathematical language and builds a base for understanding more complicated circuits. Experiments for studying the characteristics and operation of available devices have been included. There are chapters on logic circuits, flip flops, shift registers, counters and decoders, multi vibrators and 30 pages of applications. 95 pages, 135 x 210mm.

Cat BM-2453 **$9.95**

BUILD YOUR OWN TEST INSTRUMENTS

This book describes how to build 25 test instruments. These include car circuit checker, battery condition indicator, crystal/transistor-/zener diode tester, expanded scale DC volt meter, ohm meter, ohm splitter, signal generator, signal tracer, square wave generator, pulse generator, logic tracer, centre zero null indicator plus more. 40 pages, 135 x 210mm.

Cat BM-2454 **$4.95**

ELECTRONIC MUSICAL PROJECTS

This book has 30 projects to build based around musical instruments. Projects include - metronome x 4, guitar practice, accompaniment drummer, guitar bass booster, treble boost preamp, presence boost, connecting guitar pickups, guitar preamps, practice amp, envelope control, fuzz box, waa waa, echo and reverb, tremolo, sustain, phasers, bonger, percussion box, sound generators, organ etc. 52 pages 135 x 210mm. Cat BM-2450 **$5.95**

USING SEMI CONDUCTOR DIODES

This book is dedicated to diodes and it discusses most diodes available. It includes rectifiers, surge, signal, varactor, switching, light emitting and special application types which includes tunnel, hot carrier, gunn, impatt, pin etc. It then discusses applications. 68 pages 135 x 210mm.

Cat BM-2451 **$6.95**

PRACTICAL ELECTRONIC GAMES

This book describes how to build 15 different games. The projects include - electronic shooting, electronic fountain, internal co-ordination, bombarding, traffic sense, spinning wheel, who's first, electronic ding dong, electronic puzzle, electronic finish line, measure your strength, check your stability, step music and guess work. 32 pages 135 x 210mm.

Cat BM-2452 **$4.95**

EXCITING ELECTRONIC EXPERIMENTS

This book includes 15 projects for the hobbyist. These include - electronic weighing machine, measure wind, auto tape recorder, ferrous metal detector, saturable reactor, compare light intensity, over voltage AC tripper, telephone amplifier, electronic pressure gauge, electronic thermostat, variable DC power supply, electronic timer, voltmeter, transistor and diode tester capacitor evaluator. 36 pages 135 x 210mm.

Cat BM-2458 **$4.95**

USING FUNCTION GENERATORS AND PLL'S

This book explains how function generators and phase lock loops work as well as tone and FM stereo decoders. It then describes 18 circuit/projects using these devices. Some of the circuits are - tone operated switch, sequence detector, two remote controls, photo electric control, frequency indicator, function generator, flutter meter plus a lot more. 74 pages, 135 x 210mm. Cat BM-2459 **$9.95**

24 SCR PROJECTS

This book is aimed toward the novice hobbyist. The first chapter gives a basic understanding of SCR's and thyristors. The next chapter discusses electronic components in general, followed by electronic measurement, project building and obtaining and referencing components. The 2nd half of the book describes the 24 projects some of which include light organ, timer, transmit indicator, alarms, garage door opener, proximity alarm, power monitor, smoke alarm, overvoltage protection circuit, voltage doubler, slave flash unit plus more. 158 pages, 135 x 210mm.

Cat BM-2344 **$14.95**

ELECTRONIC GADGETS FOR YOU

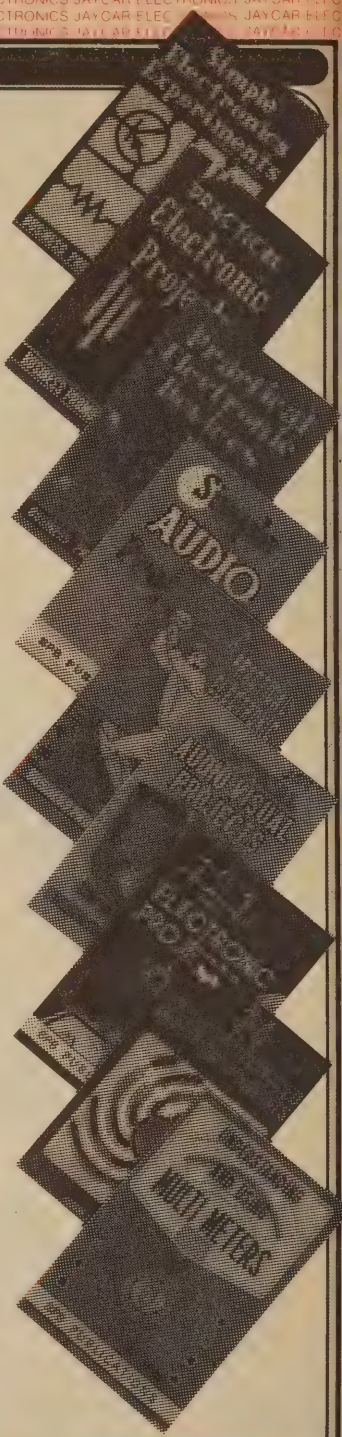
This book has 20 project. These include travelling sound, scare off thieves, carbon dioxide detection, stroboscopic lights, music on hold, light remote control, visual stereo balance, gas level indicator, electroplating, twin timer, frequency filter, solid state relay, stroboscopic sound, power and PF measurement, audio mixer, car light reminder, automatic defroster, liquid level indicator, noise meter. 38 pages 135 x 210mm. Cat BM-2457 **$4.95**

PRACTICAL ELECTRONIC PROJECTS

Sixteen projects are described in this book. They include push button lock, electronic leveller, lie detector, inductive indicator, automatic amplifier cut out, hey watchout, channel separator, audio jumbling, noise clipper, listen the resistance, sound-0-V12, sound colour conversion, small ohm meter, avoid blackouts and soil moisture meter. 36 pages. 135 x 210mm. Cat BM-2455 **$4.95**

PRACTICAL OP-AMP PROJECTS

This book is aimed at the hobbyist and technician. It describes the many functions of the OP-Amp - gain, effects of negative feedback, differential input, errors generator, block diagram and power supply diagram. It then describes 17 circuits which you can build using OP-Amps. These include amplifiers, tone generator, switches, indicators, etc. 87 pages, 135 x 210mm. Cat BM-2456 **$9.95**



POWER SUPPLIES FOR ALL OCCASIONS

This book describes batteries, unregulated supplies, voltage regulators, current regulators, switching regulators, AC regulators, inventors and converters. It then gives 32 practical deigns with circuits. These include regulators, battery eliminators and lots of power supplies. 80 pages. 135 x 210mm. Cat BM-2464 **$9.95**

SIMPLIFIED PRACTICAL FILTER DESIGN

By Irving M Gottlieb

A "back-to-basics" guide to designing and building practical electronic filters - for engineers, technicians and hobbyists. Using simple mathematics and straightforward procedures, Irving M Gottlieb promotes a thorough understanding of filter components, including how to determine their exact values and connect them properly. You'll learn common techniques for laying out and assembling • low pass filters • bandpass filters • M-derived filters • crystal filters • high-pass filters • band-rejection filters • composite filters • crossover networks • and more!

Most importantly, you'll learn the difference between real-world and "textbook" filters - discovering why filter designers are so often led astray by heavily mathematical texts - and how to avoid falling into the same trap with your own filter designs.

Cat. BT-1326 **$34.95**

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FASCINATING IC PROJECTS

By P K Aggarwal. This book has 15 projects to build using ICs. The projects include: IC regulated power supply, staircase switch, electronic multiplier, touch switch, sensitive doll, LED flasher, electronic game, stop watch, puzzles, quiz, magic switch, electricians companion, temp controlled oscillator, revolving display. 44 pages 140 x 210mm

Cat. BM-2434 **$4.95**

BUILD YOUR OWN COILS AND TRANSFORMERS

This book is a wealth of information, ideal for hobbyists or anybody interested in winding their own transformers, After the introduction the book covers attributes of coils/transformers, mutual inductance, reactance, resonance, impedance, coil selectivity. It then goes on to the design aspects - discussing coils in tuning circuits, types of formers and cores, types of winding, self capacity, equations, coil design, design of IF transformers then output and power transformers.. 55 pages 137 x 212mm

Cat. BM-2440 **$4.95**

UNDERSTANDING DIGITAL TROUBLESHOOTING

By Don L Cannon. Digital electronics continues to take over electrical, mechanical and electro-mechanical system functions. Maintenance of digital systems - the need is growing rapidly as systems switch to digital electronics. Here is an easy-to-understand format on the basic principles and troubleshooting techniques required to begin digital equipment repair and maintenance. Fully illustrated. Ideal for self-paced individual learning. 266 pages 176 x 217mm. SAVE $22

Cat. BM-2416 **$12.95**

ILLUSTRATED WORDSTAR 6.0

By Russell & Dianne Stultz. Explore the expanded functions of this full-featured word processing software using this book as your guide. Learn how to import graphics and manipulate the new scalable fonts to give all your documents that professional look. Hundreds of illustrations and examples will have the novice up and running in no time. Experienced users will find this book an indispensable reference tool. From macro creation to automatic paragraph styles, use this complete reference to master your word processing needs with Wordstar.
333 pages 153 x 224mm

Cat. BM-2118 **$22.95**

TRANSISTORS AND THYRISTORS MADE EASY

By M C Sharma. This book does a great job of introducing solid state electronics to beginners, and then build up their knowledge to a level where they can easily understand the design of commercially available equipment and also design their own circuits. Many diagrams help the reader to understand this fascinating subject. Chapter headings include: semiconductors, diodes, special purpose diodes, bipolar transistors, field effect transistors, basic amplifier circuits, transistor amplifier design, voltage amplifiers, power amplifiers, video RF and IF amps, power supplies, oscillators, pulse circuit thyristors, oplo devices. 296 pages 135 x 210mm

Cat. BM-2426 **$14.95**

MS DOS/PC DOS QUICK REFERENCE

This guide is written in a simple and logical manner for users. Chapter 1 gives an insight of MS-DOS. From there the book covers installation of MS-DOS, commands, their syntax and examples for MS-DOS version 3.3, as well as the newer versions. Also include are appendixes on the enhancement of DOS commands for version 4.01, batch file and config. sys file respectively. There is a section exclusively on partioning of hard disks. The last section is a ready reference guide to MS-DOS version 4.01. Size 187 x 120mm.

Cat. BM-2110 **$12.95**

ILLUSTRATED LOTUS 1-2-3 RELEASE 2.2

By John Mueller. Spreadsheet software for the PC. Designed for the 640K DOS environment, this version of Lotus 1-2-3 allows you to combine spreadsheets, database and graphic functions into a single program. Written in plain English, you'll find this book overflowing with complete and concise information on Lotus 1-2-3 Release 2.2. Follow the logical progression of the Recommended Learning Sequence to master the basics quickly. A macro reference is included to show you how to create your own macros. Other bonuses include appendices that show source listings for sample macros and how to create and use formulas within a worksheet. To further aid you in finding a command, a graphical representation of Lotus' menu trees is included. 339 pages, 234 x 182mm

Cat. BM-2112 **$19.95**

TOWERS DIGITAL IC SELECTOR

This book supplies over 13,000 American, European, British and Japanese digital integrated circuits, with electrical and mechanical specs, manufacturers names and pinouts. Recommended substitute part numbers also given. This is an essential book for anyone engaged in service of computers or other digital equipment or the serious digital enthusiast. 244 pages. Size 178 x 247mm 1st quality book, special purchase. SAVE $15

Cat. BM-4558 **$14.95**

TOWERS INTERNATIONAL MICROPROCESSOR SELECTOR

This book is designed to provide in one handy volume a comprehensive body of readily accessible user slanted essential information across the field of microprocessors. In the data tabulations will be found set out the essential basic specifications of over 7,000 commercially available microprocessor chips, including not only the microprocessor elements themselves (e.g. MPUs and CPUs) but also the many other LSI support circuits (e.g. ROMs, RAMSs, PROMs, clocks, UARTs, I/Os) normally used in harness with the microprocessors proper to produce complete microcomputers or microcontrollers. There is only a limited quantity of this book available and once they are gone that's it. So, if you want one, don't miss out. SAVE $7

Cat. BM-4564 **$12.95**

'I buy my books at Jaycar'

TOWERS OPAMP AND LINEAR IC SELECTOR

Over 5,000 American, British, European & Japanese linear IC's with electrical and mechanical specs, pinouts, manufacturer names, recommended substitutes etc. Manufacturers address details also given, which can be handy if you want to know more about a device. A very comprehensive technical publication and certainly the best we have seen on linears for the price! This book could be called a 2nd, but all the information of the regular one is there.192 pages. Size 180 x 260mm. SAVE $5

Cat. BM-4557 **$14.95**

386 COMPUTER HANDBOOK

By Edwin Rutsch. For owners and prospective owners of 386 computers. In a reader friendly fashion it covers OS/2, Windows 386, networking, CAD, graphic intensive programs, heavy number crunching, programming, multitasking and 32 bit software applications. The reference section offers:- Instructions for upgrading an IBM XT and AT type computer to a true 386 system. Money saving tips on how to expand your 386 by adding 3 1/2" drives, a hard disk, memory, Improved BIOS, 80387 math coprocessor, VGA, enhanced keyboard, "Micro Channel" motherboard, modem. Illustrated instructions for assembling a 386 system and easy to understand troubleshooting instructions. There is also a buyers guide section giving explanations of computer terms and trends, hints on how to buy a computer system and reviews of major (US) suppliers.454 pages, 216 x 143mm

Cat. BM-2116 **$19.95**

UNDERSTANDING DIGITAL TROUBLESHOOTING

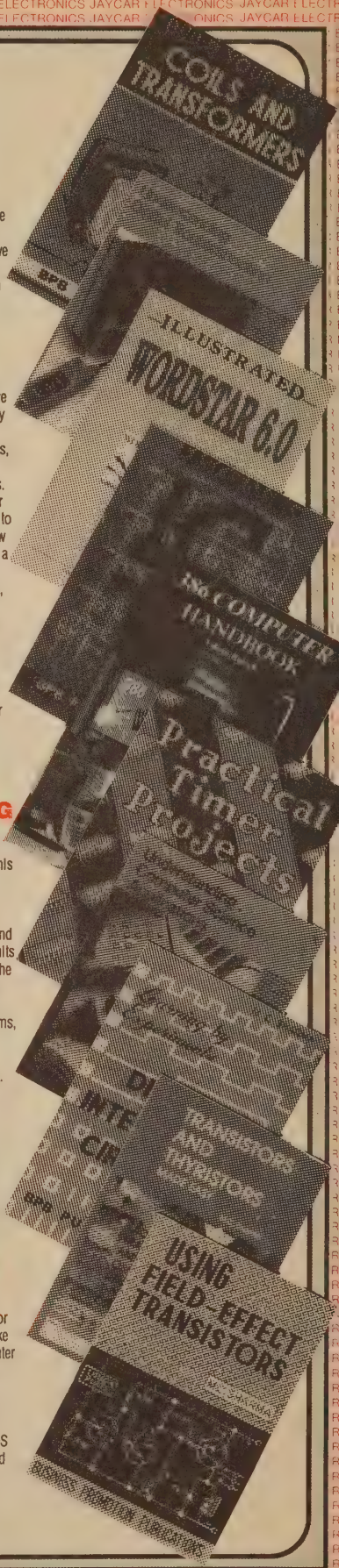
By Don L. Cannon. Digital electronics continues to take over electrical, mechanical and electro-mechanical system functions. This book provides an insight into this high technology world in a language that both technicians and non-engineers can understand. It presents the basic concepts and fundamental techniques needed to locate faults in digital systems and how to repair them. The chapters are:- Digital System Fundamentals, Digital System Functions, Troubleshooting Fundamentals, Combinational Logic Problems, Sequential Logic Problems, Memory Problems, Input/Output Problems, Basic Timing Problems and Advanced Techniques. 266 pages size 176 x 222mm.
This is a genuine Sams book in the "Understanding" range. Other books in this sell for $34.95, as this one should. We have made a special purchase and can offer this book with a limited quantity for only $12.95, saving you over 60% on normal prices.
SAVE $22

Cat. BM-2416 **$12.95**

BEGINNERS GUIDE TO THE IBM PC

By Bruce Collins
This book assumes that you have very little or no knowledge of using a computer. It will take your hand and guide you through the computer maze. By the last chapter, you will certainly know your way around your new IBM compatible or genuine computer. The book covers such topics as:- what is a computer?, format and copy commands, disk drives, DOS commands, software generally, computer add ons, maintenance and a lot more.
An ideal book for a computer novice.
Softcover, 69 pages, 210 x 140mm.

Cat. BC-1120 **$9.95**



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SUPER BULLET TWEETER

Another surplus bargain. These are a piezo Hi Fi tweeter, but in a strange shape. They were used in a Kangaroo scaring device, but the manufacturers had a model change and these became surplus. The specifications are similar to our economy piezo tweeter (Cat. CT-1905), but the shape is rather different.

NEW

SPECIFICATIONS
Frequency Response 800 - 40k
Peak Power 75 watts intermittent
Use with or without crossovers. Size 50mm diameter, 60mm mounting holes, length 75mm including bullet.
Cat. CT-1906

ONLY $2.95
10+ less 10%
100+ $2.00 ea

BUILD A ROW OF DIRECTIONAL TWEETERS

WIRE ON SMALL REELS

NEW

You know the scenario! You buy a few metres of cable and by the time you get round to using it, it's all messed up and it takes you twice as long because half the time is spent on untangling it. It's not only frustrating - it can damage the cable. Jaycar has now solved your problem! Our most popular cables are on small reels.

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CLICK SURGEBUSTERS

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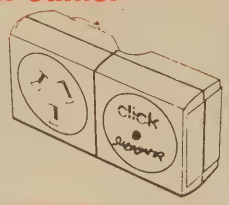
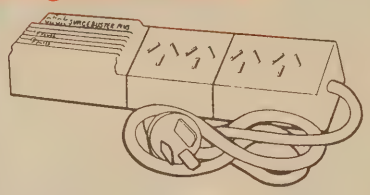


Safety assured surge protected power outlet plus $5,000 FREE insurance against damaging voltage spikes and power surges.
Cat. MS-4010

$29.95

Surgebuster Plus



High level protection against damaging power surges plus provides line noise filtering to minimise electrical interference. 4 protected outlets and overload cut-out. Recommended for PC's, Hi Fi and other valuable electronic equipment.
Plus $5,000 FREE insurance
Cat. MS-4012

NEW

$99.95

4 Way Power Board

with overload protection
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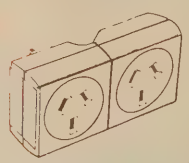
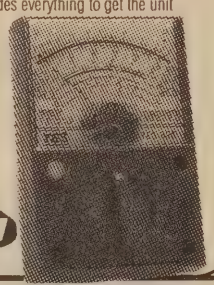


Cat. PP-4035

$4.25

NEW MULTIMETER KIT

An excellent way to learn about electronics and the result will be a quality analogue multimeter you can use for years. Ideal for the educational area, schools, etc.
The unit is supplied partially assembled, there is however, some soldering required. Kit includes everything to get the unit operational including leads and probes and batteries.



SPECIFICATIONS
- 20,000 ohm/volt
- Continuity buzzer
- 1.5V battery check
- dB measurements
- Diode & fuse protected
- 19 ranges

Cat. KC-5058

NEW

$37.95

FAKE CAR ALARM

Save your car for less than $5!
Were selling for $19.95!

It's a black box with 12 digits on the top and a flashing LED. It looks very similar to the controller on a very expensive car alarm (the one that guarantees your car won't be stolen.)
So, with this sitting on your dash, would be thieves will think you have a high quality alarm, and move on.
Can be used on its own, or to complement any existing alarm system.
Use on cars, around the home, on boats, etc. Easy to install, size 70 x 50mm, sticky tape already supplied on back. Includes alarm sticker. Requires 2 x AAA batteries (not included) Cat. SB-2375
$1.95 for two.
Cat. LA-5105

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SAVE 75% over 1988 price

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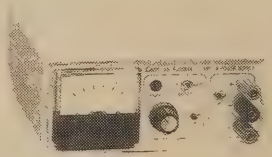
NEW KIT

LOW COST 18V 1A BENCHTOP SUPPLY KIT

Ref: EA August 1991
This economy priced power supply features: • variable output voltage from 2.5 to 18V • switchable current limiting • both voltage and current metering. The Jaycar kit includes PCB, all specified components, Scotchcal panel and meter scale.
Cat. KA-1736



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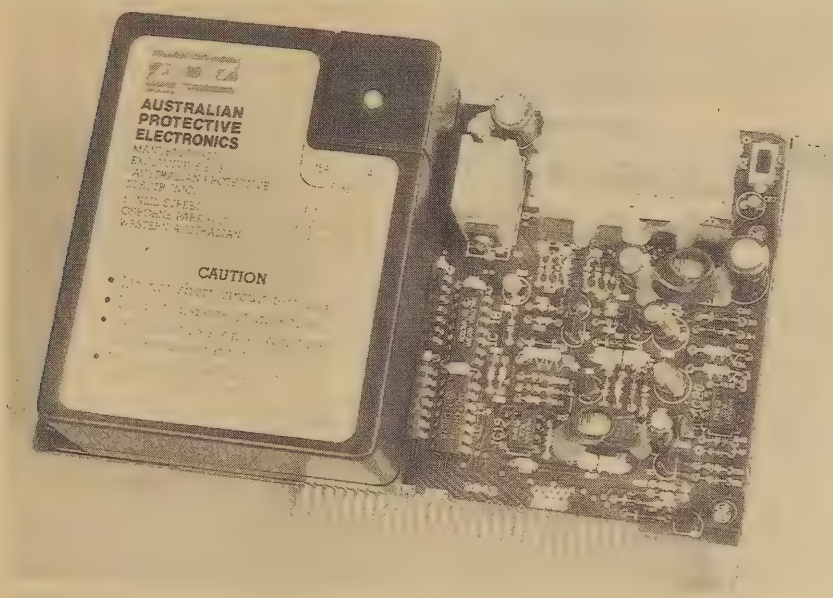


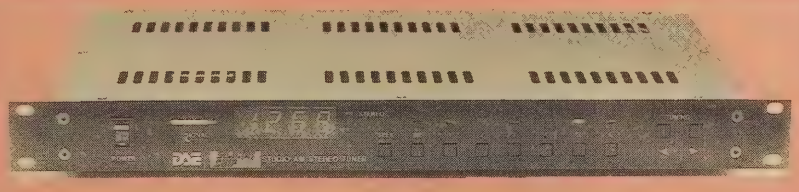
UPS for PCs comes on a card

The days of bulky uninterruptible power supplies may be limited if the new SafeCard from Rod Irving Electronics is anything to go by. It is a complete uninterruptible power supply which fits right inside your computer, plugging into one of the expansion slots. In fact, it only is the size of a standard IBM half-card, although it needs the space of two slots since it is quite thick because of the on-board battery pack.

Because it only provides the low voltage DC rails, it can be much more compact than a conventional uninterruptible power supply. It provides power for long enough to have the computer save all its currently working files to hard disc and then power down. In fact, in the event of a power failure for more than one second, the Safecard automatically stores all memory (system, extended and video) on the hard disc. And when the power comes back on again, all memory will be reinstated.

To install the Safecard, you need an IBM PC/XT, AT or compatible with 512Kb to 1Mb main memory, a hard disc and DOS 3.0 or higher. The unit comes complete with an instruction manual and user software, all the connectors and cables required, and a 12-month warranty.

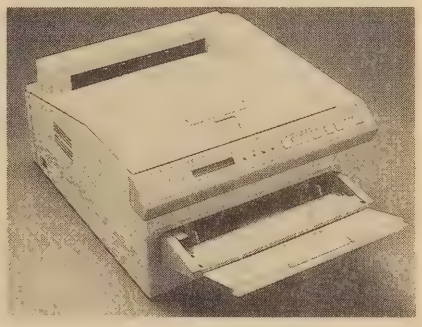
At $595.00, it's a worthwhile insurance policy. For more details contact Rod Irving Electronics.



AM stereo tuner kit available from DSE

Those who have been waiting for the kit for the AM stereo tuner described in the February, March and April 1991 issues of SILICON CHIP will be pleased to know that Dick Smith Electronics now has a very fine kit complete to the last detail. It has an excellent finish which will complement your other hifi equipment. The price? Very reasonable, at just $199. See the kit now at your nearest Dick Smith Electronics store.

Facit laser printer from Elmeasco



Elmeasco, the Australian distributor for Facit, now has available the new model P8040 laser printer. This unit is ideal for word processing, graphics and desktop publishing.

The P8040 prints at a four pages/min rate and occupies little desk space. It has 14 resident fonts and will accept HP LaserJet font cartridges and soft fonts.

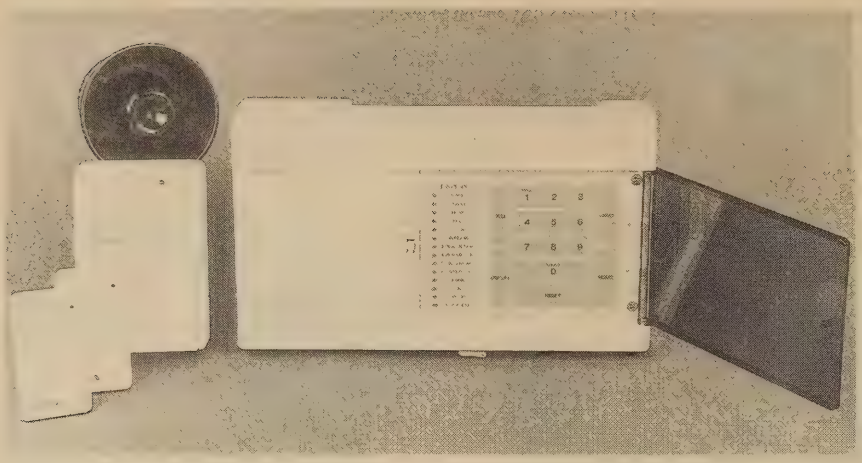
It's also quiet, with a 46dBA noise output, making it suitable for office applications.

It comes with 512Kb memory which can be expanded to 2.5Mb, as well as Centronics parallel and RS232C/RS422A serial interfaces.

For more details, contact Paul Twigg at Elmeasco Instruments Pty Ltd, PO Box 30, Concord 2137. Phone 02 736 2888.

Wireless security system from Altronics

Security systems are a great idea but the hassle of all that wiring is certainly a drawback. The answer is to use a wireless security system which uses radio links from the sen-



sors instead of cables.

This Zeus wireless security system comes with a microprocessor control console, a 10-watt siren, a door/window sensor, a personal remote control (with panic button), a passive infrared (PIR) sensor, and a 12V SLA battery and plugpack.

Also included is a fairly comprehensive user manual which explains how the system works and how it can be used effectively. The system can be easily extended with additional PIR or door/window sensors.

At $649.00 for the basic system described above, it's pretty good value. For further details, contact Altronics Distributors on (09) 328 2199.

Top-end car CD system from Philips

If you're looking for something more than just the average car CD system, then Philips' new DC980 system is certainly worth considering. It comprises a high-performance CD player, a 3-band AM/FM receiver and a 25W stereo power amplifier, all in the DIN standard car radio package.

The tuner is microprocessor controlled and has an autostore feature which enables the tuner to locate and store the six strongest AM and FM stations in memory.

A further six FM stations can be stored manually. A built-in battery maintains the memory when the unit is switched off.

The CD player uses a dynamic range compressor which increases the volume of soft passages to overcome the engine noise of your car. It also features random play and "music scan", where the first 10 seconds of each track are played.

The LCD screen displays run-times for the current track as well as for the disc, and you can even swap the colour between orange & green to match your car's dashboard illumination.

The power amplifier can also drive two sets of speakers and a front/rear fader control allows you to customise the listening spread.

At $799.00, it certainly is a high-class system well worth the look. For further enquiries, contact Philips Car Radio on (03) 790 0777.

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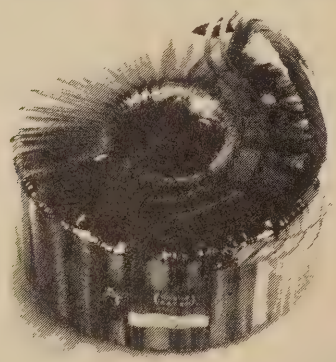

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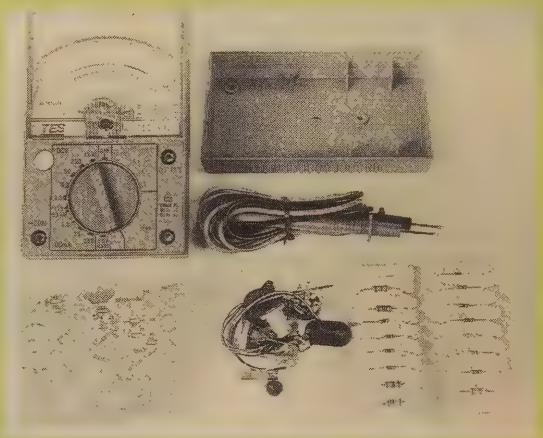


Do-it-yourself analog multimeter

One of the best ways to learn how a multimeter works is to go out and build one. Jaycar Electronics now has available the TES 308 analog multimeter kit, which contains all the components and instructions necessary to build an attractive analog multimeter.

It can measure DC and AC volts from 2.5 to 1000 volts, DC current from 50μA to 250mA and resistance to 20MΩ. It also has a 1.5V battery test so you can check those questionable penlight cells lying

continued on page 57

COMPUTER BITS

BY JENNIFER BONNITCHA

Installing Windows on your PC

Windows 3.0 provides you with a consistent application interface. It is easy to learn and use, and features Dynamic Data Exchange for efficient transfer of data between programs. Naturally, to achieve the best from Windows, some training is essential.

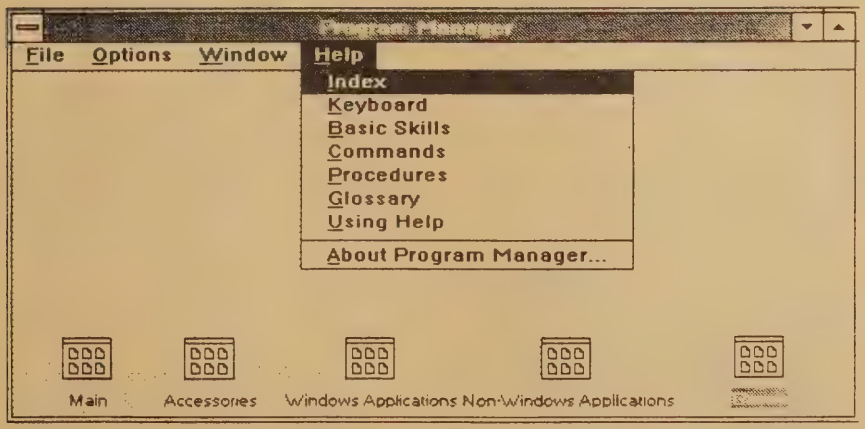
Windows is an operating environment that works in conjunction with your computer and the MS-DOS or PC-DOS operating system. It has an easy-to-use graphical user interface (GUI) that resembles and works like a desktop in that you can perform multiple tasks at the same time.

You can share text, data and graphics between applications and perform most of your work and file maintenance without returning to DOS. Windows has a "What You See Is What You Get" (WYSIWYG) display, which means that all the on-screen text and graphics appear the way they will look when printed.

The conventional DOS PC looks pretty ordinary to most users - when you press a key you see a character and if you get all the keys in the right sequence, you get a result. Windows has changed all that for the PC user by establishing a more acceptable common appearance across many applications. You will soon get the hang of a new Windows application since many of the menus provide identical commands - although each application will have its own particular menus and the options contained within the menu will vary.

The installation procedure couldn't be easier. You place Disk 1 of the disc set into the appropriate disc drive and then type SETUP at the DOS prompt. You are guided through the installation which first evaluates your computer system to determine what kind of equipment you have at your disposal. The essential Windows files are copied onto your hard disc and you are asked to verify vital information - although you can make any changes you feel are necessary.

Following the preliminary installation, Windows starts (courtesy of the Setup program) so that you can choose and configure your printer, install any software programs and view the supplied on-line documents. During Setup, you are asked whether you want Windows to install all programs it can find on your hard disc.



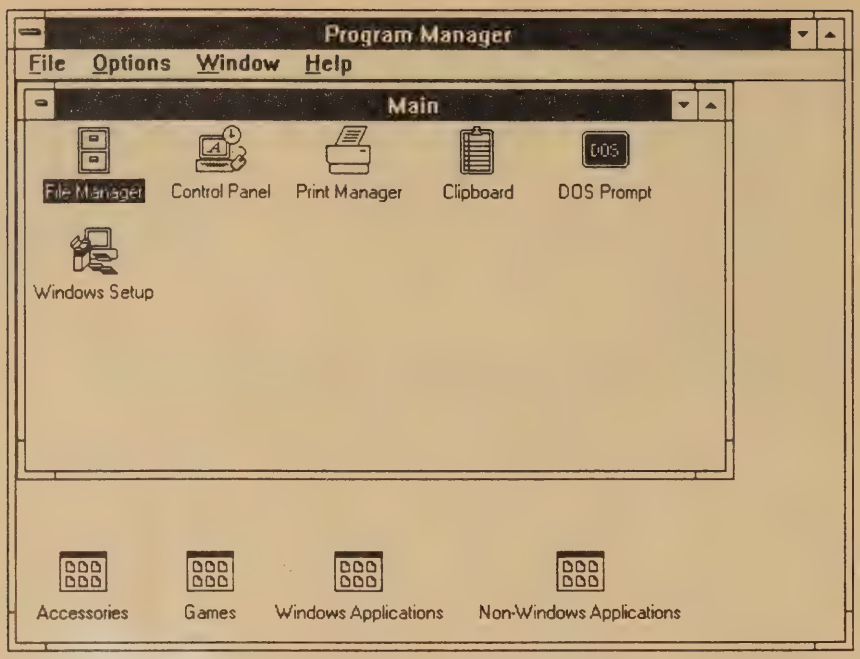
The Program Manager starts automatically when you start Windows and it continues running for as long as you use Windows. The program group icons are shown along the bottom of the screen but you can customise Windows so that the Program Manager opens any or all of the groups as windows at start-up. Note the drop-down menu that appears when Help is clicked.

Let Windows do the work

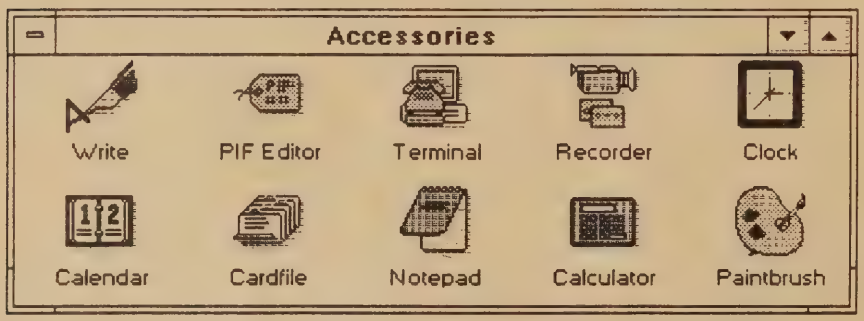
For your first-time installation you may prefer to let Windows do all the work since it is quite easy to add (or delete) further applications. Most of the questions Setup asks are self-explanatory, however Help is always just a key away - press F1 at any time for on-line Help. Following installation, you can run Setup again at any time to review or change some of the options you originally selected - you may take delivery of a shiny, new printer or a next-generation mouse for example.

Windows' GUI helps you to operate your computer using graphic symbols or icons. The mouse enables you to point at and select the necessary objects to complete a task with ease. Windows also provides two basic types of windows - the application window and the document window.

The application window displays a currently running application (like Windows Word or Excel), while the document window displays informa-



The various group windows (in this case, the Main window) are opened by double clicking on the Program Group icons. By now double clicking on the Control Panel icon, you can customise the way Windows appears and operates.



The Accessories window contains a number of programs, including Write, Terminal (for communications), Recorder, Cardfile & Calculator. The group window can be enlarged to full screen size by clicking on the up-arrow symbol in the top righthand corner, or shrunk to an icon by clicking on the down-arrow.

tion about or for an application (like a Windows Word document or an Excel worksheet). Document windows lack a menu bar since all the commands for controlling the application are provided on the Application (eg, Excel, etc) menu bar.

Operating modes

Windows starts in one of three modes, depending on your computer's hardware configuration. You can check which mode Windows is running on your computer by selecting Help from the Program Manager menu bar, then About Program Manager. These modes were described in detail last month but are in summary:

- Real Mode: 8086 or 8088 processor, 640Kb RAM; 80286, 386 or 486 with less than 256Kb extended RAM. This mode provides maximum compatibility with previous versions of Windows applications, however any extended memory is ignored.
- Standard Mode: 80286 or higher processor with a minimum 1Mb RAM (640Kb conventional, 256Kb extended). This is the normal operating mode for Windows and is the best mode for running DOS applications.
- Enhanced Mode: optimum operating mode - 80386 or higher processor with 640Kb conventional and at least 1024Kb extended memory. This mode enables most non-Windows applications to run in windows rather than as a full-screen application.

Windows applications which have not been updated to run with Windows 3.0 require Real Mode. Typing WIN causes Windows to look at your computer's configuration and start in the most appropriate mode. You may want Windows to start in different modes, even though it may not be the most appropriate for your computer. These switches are available for you to use:

- /R Real Mode - useful for running applications designed for earlier versions of Windows.
- /S Standard Mode - the "usual" mode for Windows on 80286 or higher computers with at least 1Mb of memory. Windows runs faster in this mode on an 80386 computer with between 2-3Mb of memory - provided you use only Windows applications - otherwise choose 386 mode.

Windows is also capable of automatically starting an application such as Windows Word. The following command starts Windows then runs the application:

```
WIN C:\WINWORD\
WINWORD.EXE
```

Similarly, the following command line tells Windows to start Windows, then Windows Word and finally to load the SAMPLE.DOC file:

```
WIN C:\WINWORD\
WINWORD.EXE SAMPLE.DOC
```

There are many other options for starting Windows by modifying the initialisation files, WIN.INI and SYSTEM.INI - all of which will be covered in more detail next month.

Windows Desktop

Once you start Windows, you will be presented with a desktop containing several more windows. You can change the size and location of any window at any time and when you exit from Windows, you have the option to save any changes you may have made. The Program Manager starts automatically when you start Windows and it continues running for as long as you use Windows. It is the centre of Windows since all applications are started from here.

You should see a group of Program Group icons at the bottom of the Program Manager window with names such as Main, Accessories, Windows

Applications, Non-Windows Applications, Games, etc. Your computer may contain more or less icons, depending on which applications you told Windows to install from your hard disc. The very first time you start Windows, the Program Manager opens the Main window for you.

The Program Groups are windows containing program item icons for the applications you installed and the applications you use to manage and operate Windows. The Accessories program group contains the productivity tools - Windows Write, Paintbrush, Calculator, Cardfile, etc. Next month, you will see how to create a new program group, place program items, copy and move program icons between groups, and delete icons no longer required.

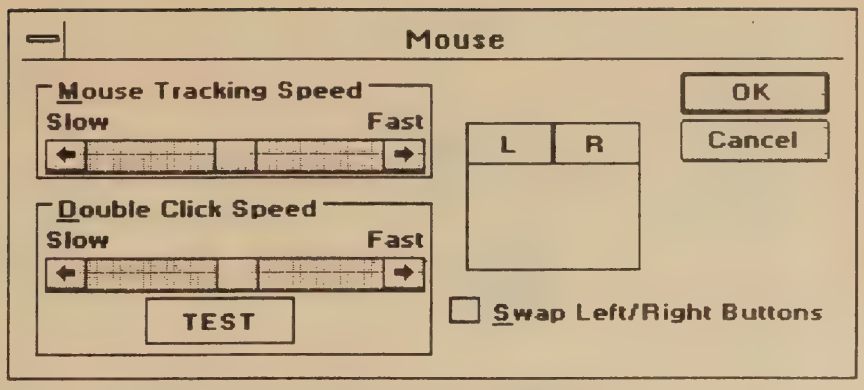
Operating the desktop is relatively easy with the mouse although a little practice is required if you are new to the rodent. The main mouse operations are clicking and dragging. To choose an item, position the mouse pointer (the tip is the most sensitive area) then click (press the left button and release) the mouse.

You click to open menus, choose items from the menus and dialog boxes, scroll windows and to select windows. Double clicking (quickly pressing the left button twice) enables you to select items from the Program Group windows - to run a program, for example. Dragging involves moving the mouse to the required position and then pressing and holding the left mouse button. You can drag a window to a new location and/or change its size, for example.

You can open the Main window if necessary by double clicking on the Main icon. By now double clicking on the Control Panel icon, you can customise the way Windows appears and operates. You can adjust many hardware and software settings, including which button is the main working button on the mouse.

Mouse dialog box

Double clicking on the mouse icon opens the Mouse dialog box. Now you can change the tracking speed (how fast the mouse moves across the screen) and the double click speed (use the TEST button to determine how fast you need to double click to highlight and un-highlight the box). And for the long-neglected left handers, you can swap the left and right buttons!



You can change the speed of your mouse by double-clicking on the Control Panel icon in the Main window, then double-clicking the Mouse icon to open the mouse dialog box. This box also lets you swap the left & right buttons.

When you are satisfied, click on OK to save the changes and return to the Control Panel.

You now double click on the Application Menu icon (the large minus sign at the top left of the Control Panel window) to close the Control Panel and return to the Main window. Continue double clicking on any remaining windows to close each in turn. When the Program Manager remains, double clicking will close Windows.

There are many other customisation features available on the Contol Panel, including selecting windows colours and customising the design and operation of your desktop. We'll discuss these options next month. **SC**

Product Showcase - from page 54

around in the drawer, and there is provision to use a thermistor temperature probe covering the range from -30°C to +200°C.

For $37.95, it's a good investment in learning how multimeters are designed and built. You can see it at any Jaycar Electronics store.

New ferrite material optimised for 200kHz

Siemens Matsushita Components (S & M) has developed a new high permeability ferrite material optimised for 200kHz.

Called T37, it is optimised for frequencies to about 200kHz, has a maximum initial permeability of typically 6500-7000, and supplements the existing T35 and T38 range. The T35 material is suitable for frequencies up to 400kHz but exhibits lower permeability. The T38 material, however, has a permeability in excess of 10,000 and is suitable up to 100kHz.

For further information, contact Robert Fontana at Siemens Ltd, 544 Church St, Richmond, 3121. Phone (03) 420 7313. **SC**

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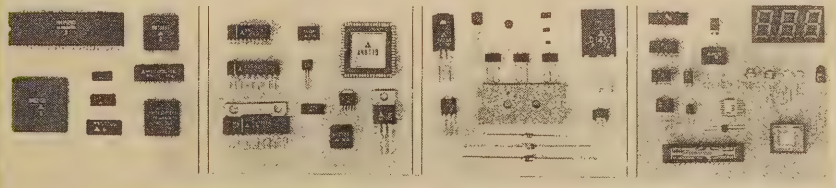

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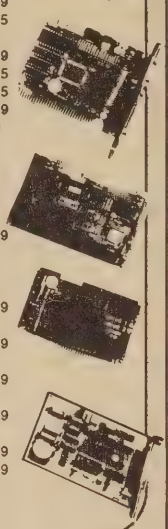

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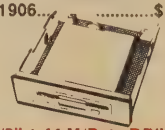

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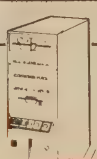

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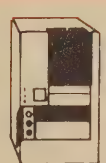

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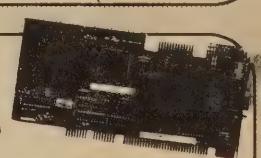

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SERVICEMAN'S LOG

The case of the blowing fuses

I'm kicking off this month with a mystery story from J. L., our regular contributor from Tasmania. I've chosen this sequence because, after reading his story, I had a chance to work on a couple of similar chassis and make some further observations. They may help a little.

What follows in in J. L.'s words. Here's how he tells it.

This is a story without any real ending. It has had me thinking for a long time and I still don't have a certain answer. I can make a convincing guess as to the cause but I'm not sure. See what you think.

The set was a General Electric TC53L2, a 53cm model, fitted with an Hitachi NP6A-A chassis. I don't think that has anything to do with the fault or the cure. It could have been any model of any brand of similar vintage.

The set came in for an intermittent "no go". This model offers two possibilities for this fault. One is a faulty joint under the clamping screw for the horizontal output transistor collector. The other is a loose connection to the emitter of this transistor (it uses a slip-on connector which is apt to come loose). Either fault is easy to cure and, in this case, I replaced the slip-on connector with a hard wired lead, soldered to the emitter pin. It was a total cure - for that fault.

The customer returns

Unfortunately, the customer didn't agree. He was back within a week for what he said was "the same trouble". It wasn't though; this time it was the main HT fuse, F903, a 1A time delay type, that had gone open circuit.

The fuse had blown gently. It wasn't just broken - as through old age - nor had it blown violently. But it had blown through over-current and I needed to know why.

This chassis uses an isolating transformer, T951, feeding a bridge rectifier and then a chopper type regulator delivering 125V to the rest of the set. Fuse F903 is between the positive output of the bridge rectifier and the chopper transformer, T902.

Apart from the unlikely event of a short to chassis in the chopper transformer, a shorted chopper transistor, TR906, is about the only thing likely to take out the fuse.

The only other connections to this rail are C910 (a 4.7µF 400V electrolytic kickstart capacitor) and the R908/R935/R909 network which supplies HT to the chopper pre-drive transistor, TR904. Both these connections are quite high impedance, so a short to chassis is an unlikely result if any of these components breaks down.

So, after considering all these points, I decided that it had to be a leaky chopper transistor. An in-circuit test indicated that the transistor was OK but, in the absence of any other indication, I felt that it had to be faulty in some way or other. So out it came and in went another one.

I fitted a new fuse and switched on. Up came a perfect picture - for about an hour. The new fuse then failed just as the first one had done.

I tried again and again but the fuses lasted from only 15 minutes to an hour before failing. I checked everything I could think of that might be overloading the fuse but every voltage or resistance that I tested appeared to be well within tolerance.

Thermal cutout

By this time, I was running out of fuses, so I firkled about (good word, that) in the junkbox until I found an old 1.5A thermal cutout, rated to trip at 3A. With this clipped into circuit, the set ran for many hours without any trouble.

As far as I could tell, nothing was overheating, there were no excessive voltages, and there was no sign of incorrect picture geometry. The set seemed to be operating perfectly within normal limits.

With everything apparently normal, I guessed that it would be OK to refit the correct 1A fuse. But I was wrong. It lasted only 10 minutes. So I fitted a 1.5A fuse and, as far as I know, the set is still going strong.

I have racked my brain trying to work out what could have caused the trouble. I'll swear there was nothing wrong with the set, yet it would not work with the correct fuse fitted.

The theory I have come up with is this. See if you agree.

Most domestic electrical equipment is designed around component val-

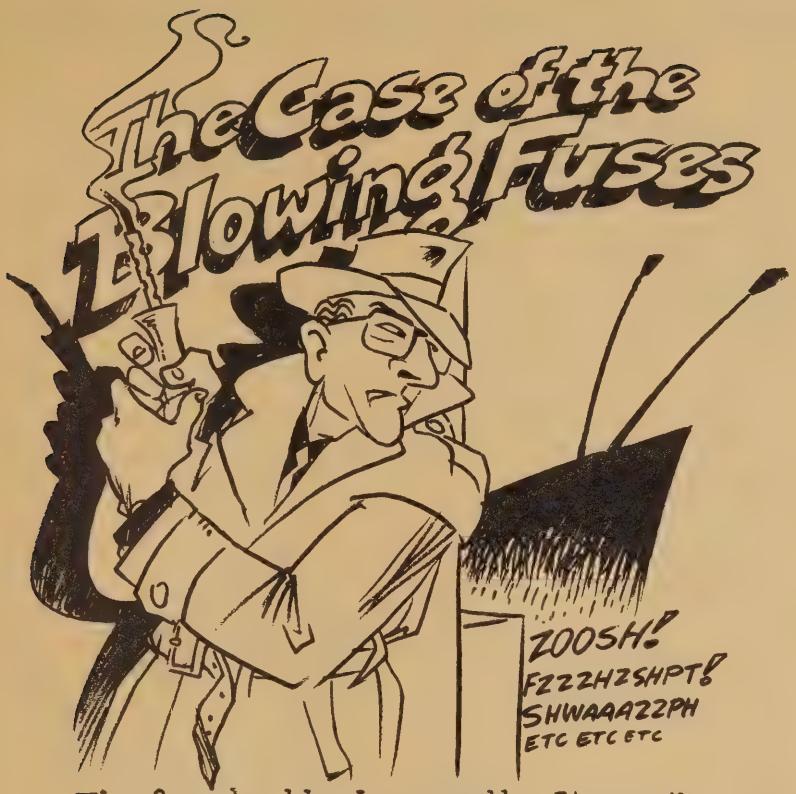
TETIA TV TIP

Hitachi CEP288, CEP289 (PAL3-A chassis).

Symptom: Reduced height, about 2cm of black at top and bottom of screen. No colour. The picture can recover to normal after 10 minutes but the fault does not appear to be heat sensitive.

Cure: C753 (100µF/25V electro) open circuit. This cap is the input to the filter on the 20V rail and its loss causes the rail voltage to drop, in this case to 14V. The rail shows no unusual ripple, just a lower than normal voltage.

TETIA TV Tip is supplied by the Tasmanian branch of the Electronic Technician's Institute of Australia. Contact Jim Lawler, 16 Adina St, Geilston Bay, 7015.



The fuse had broken gently. It wasn't just broken—nor had it blown violently.... ....But it had blown through overcurrent — and I needed to know why

ues with a ±20% tolerance. Some parts have a closer tolerance but many are 20% because anything closer would be unnecessarily expensive.

The law of averages dictates that the tolerances in an average set will be spread evenly between the upper and lower limits. But occasionally there must be a set that gets a preponderance of plus components; or of minus components.

Fuses, on the other hand, must always have a positive tolerance. The designer must select a fuse value above the steady state current in the circuit to be protected. Quite obviously, a negative value fuse would blow every time the set was turned on.

We can assume that the designer selected a fuse that would have a safe margin over the steady current, but not so much over that it would be too slow to act in the event of an overload.

But what would happen if all those 20% component tolerances accumulated in the direction that increased the normal current in the fused circuit? The set would still work normally and the fuse would continue to carry the required current, but with less tolerance to an overload.

And, finally, component values change as the set ages. What would happen if these changes accumulated in the direction that added just marginally to the circuit current?

The fuse could no longer stand the strain and would pop after only a few minutes. I think this is what happened to the General Electric set that inspired this story.

The problem is, what am I going to do about it? The cause is probably the accumulated result of a milliamp or two of extra current in every resistor in the set. Restoring them all would be a prohibitive job.

On the other hand, the total current being used by the set does not seem to be enough to raise the temperature of any part of the chassis, so is the slight overload in any way dangerous? I don't think so.

I have suggested to the owner that he ensure that the set has good ventilation and that he contact me at any sign of overheating. Somehow, I don't think we'll have any trouble.

Another explanation

OK., so that's J. L.'s story. In answer to the implied question as to what I think, I'm afraid that, to coin a phrase, "I dunno please".

J. L.'s theory is an interesting one but I have some reservations about it. For one thing, I question the 20% tolerance figure. This was true in the bad old days of moulded muck and crude carbon resistors but 5% has been a generally accepted figure for a some time now. And, in most cases, the product is well within this limit. But OK, let's accept 20% for the sake of argument.

I held this story for some time after I received it, hoping that a similar model would turn up on my own bench. Sure enough, not one but two came in - a TC53L2 (53cm) model, as above, and a TC63L1 which is a 63cm set using virtually the same chassis.

Unfortunately, they didn't help much. The first thing I did, once I had a chassis working properly (more on this later), was to measure the current through F903. This came out as 275mA for a black screen and 370mA for a full white screen.

But even the full white value is only a little over one third of the fuse rating, with some margin due to the slow-blow characteristic. On a steady state basis, that doesn't fit in very well with the 20% theory.

And that suggests a surge of some kind. Two possibilities come to mind. One is a switch-on surge which, while not quite heavy enough to take the fuse out immediately, weakens it so that it lasts only a few minutes.

The other is an intermittent fault - perhaps thermally sensitive - which takes the current just above the fuse rating, then clears itself in the time it takes to replace the fuse.

Of course, it is easy to propound such theories but quite another to prove them. In practice, of course, few of us have anything like the necessary facilities; nor do we always have the time to tackle subtle faults like this. So thanks for the story J. L., but I say again, "I dunno please".

A real swine

So what about the two General Electric sets on my own bench? One of

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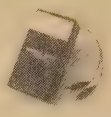

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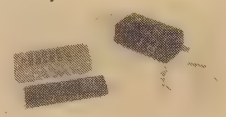

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these, the TC63L1, turned out to have a real swine of an intermittent. It lead me up several garden paths and was finally cured more on a brute force than scientific basis. Nevertheless, some of test routines are worth noting for reference.

The customer used the set in a holiday cottage up the coast, and his complaint was that "it stops now and again". In greater detail, it turned out that the failure was fairly infrequent; it would run perfectly for days, or even weeks. And, when it did fail, normal operation could be restored by simply flicking the on-off switch.

This had been going on for some considerable time but, while ever the set responded to this simple treatment, the owner was prepared to live with it. However, the day came when it didn't respond, at least not immediately, and a goodly chunk of an interesting program was lost. That was when the owner decided that something had to be done and it landed on my bench.

Of course, it started as soon as I switched it on and ran for several days. And when it finally did fail, and on subsequent occasions, I found it difficult to make any worthwhile checks. It would come good at the slightest touch but I did manage to establish that there was no 125V HT rail out of the power supply when the fault appeared.

I had no doubts that the fault was a dry joint; this chassis is notorious for them. These dry joints are found mainly on the power supply board and on the horizontal section of the deflection boards.

And this is what makes it hard. The chopper/regulator system in the power supply board (TR903, TR904, TR905 & TR906) is driven with pulses from the horizontal output stage. But the horizontal system can't deliver these pulses until the power supply delivers voltage to the HT rail. And the power supply can't deliver this voltage until it receives pulses from the horizontal system.

In practice, this deadlock is broken with a kick-start system; a multivibrator circuit consisting of TR901 & TR902 which is activated briefly from the bridge rectifier via C910. At switch on, it delivers a few pulses to the "pre-drive" transistor, TR904, to get things started.

This is a fairly universal technique and is all very clever. But when the system collapses and there is no HT rail, there is nothing to indicate whether the fault is in the power supply or in the horizontal system.

After several abortive attempts to get any kind of a lead, I settled for a routine search for obvious dry joints. I concentrated mainly on the power supply board and, in particular, a number of 2W and 5W resistors, such as R908, 909, 935, 928 and 924.

In order to aid heat dissipation, these resistors are mounted clear of the board, supported by short metal tubes which go through the board to the copper side, where they are soldered to the copper pattern. The resistor pigtails go down these tubes and are, supposedly, soldered to the them during the flow soldering process.

Unfortunately, this doesn't always work. One problem is that the pigtails are sometimes cut short and the solder doesn't reach them. But even when the pigtails are full length, the bond between them and the tube, or between the tube and the copper pattern, is often poor.

So one of the routine jobs with faults like this is to go over all these joints and resolder them. Having done this, I checked the rest of the board and resoldered a few other suspicious looking joints just to be sure.

I ran the set for several days and it behaved perfectly. But it had done this many times before and I needed more proof than that. By this stage, however, some six weeks had elapsed and the owner came in to check on my progress. More specifically, he wanted to see whether it would be available for another stint up the coast.

I explained the situation and emphasised that I could make no claim to having cured the fault. Nevertheless, he was keen to take it and give it a try, so I said, "OK, but be warned".

It's not cured

That was the last I saw of it for several months. Then, suddenly, the owner turned up with it again. It was

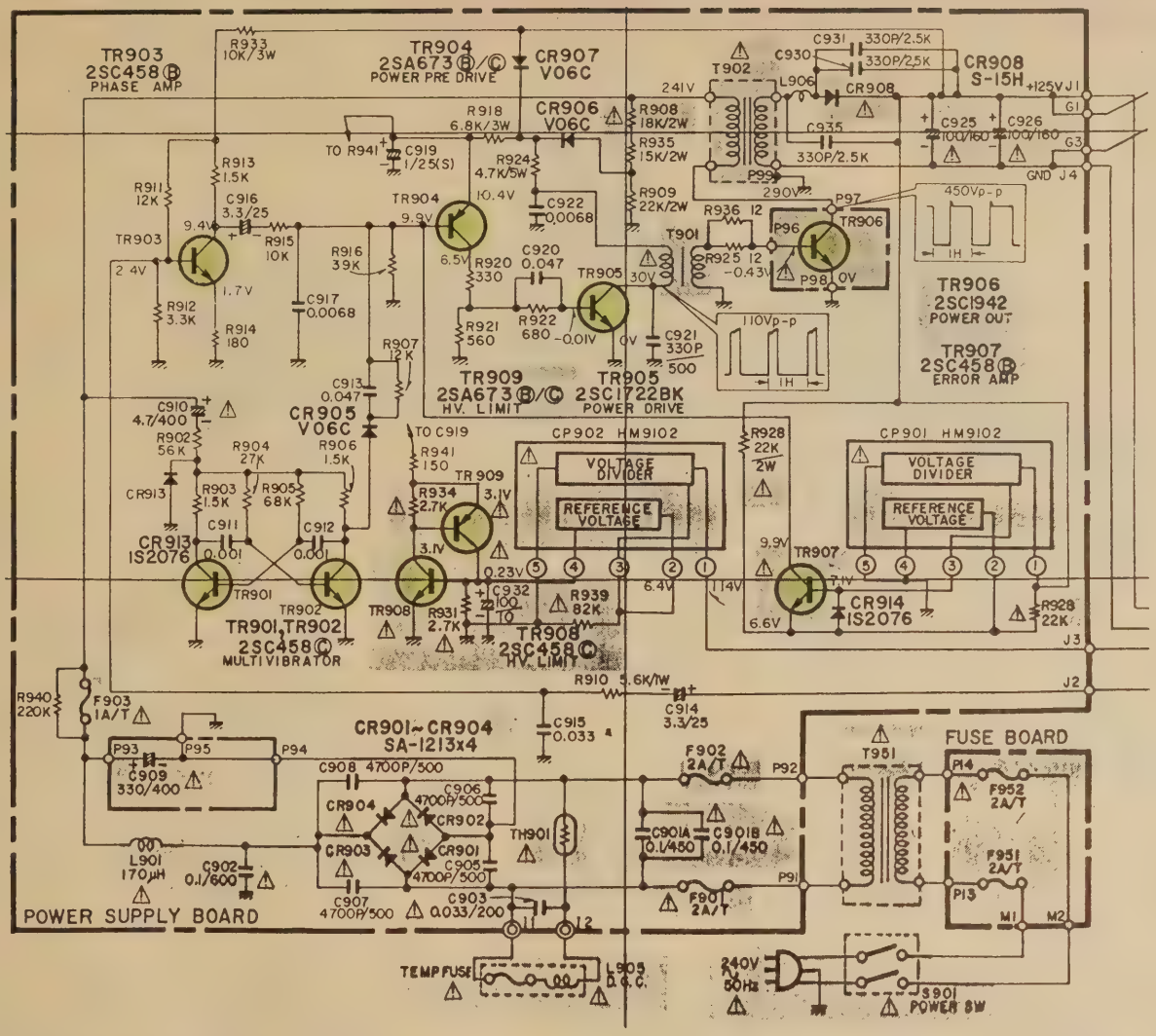

Fig.1: the power supply board for the GE-TC63L1 & GE-TC53L2 TV sets. The output from the bridge rectifier is applied via fuse F903 (lower left) to isolating transformer T902 (top) which is switched by chopper transistor TR906. TR901 & TR902 form a multivibrator circuit which is briefly powered up at switch-on to deliver pulses to TR904 to kick-start the chopper circuit. TR908 & TR909 provide over-voltage protection & this circuit can be disabled by disconnecting R941.

the same old story; initially, it would run for a long period, fail, respond to the on-off routine, and run for another long period. It had now again reached the stage where it failed to respond to this treatment, even after repeated tries.

I switched it on while the owner was there. And, yes, it was completely dead. So I felt that, at last, I might get to grips with it.

Another bonus was that it was not likely to be needed again for several months and I could take my time. So I put it aside for several days due to pressure of other jobs. And that was a mistake; when I did finally switch it on, it came good immediately. Back to square one.

This time I decided to try a different approach. The trick is to bypass the chopper/regulator section of the power supply and run the set directly from the bridge rectifier. If it fails in this configuration, the fault is almost certainly in the horizontal system and, in any case, with power still applied, one has a better chance to track it down.

It's a simple trick. The set is fed from a Variac and a jumper lead is used to connect fuse F903 to the cathode side of diode CR908 (top right of circuit, near T902). The Variac is then wound up until the voltage at this point reaches 125V - or a little less to provide a safety margin.

I set everything up to enable me to quickly do this and then left the set running, waiting for it to fail. Eventually, it did and, what's more, it refused to start using the off/on technique. This was the ideal opportunity for the bypass trick - I quickly connected the jumper lead and wound the Variac up, whereupon the set leapt into life. And it kept on going.

From this I deduced that the fault

was in the power supply and spent some time going over the board again, looking for an elusive dry joint which I might have missed the first time. I drew a blank.

There are a couple of other tricks one can try in this situation. First, by bridging capacitor C910 with a 1kΩ resistor, the multivibrator can be made to run continuously, regardless of the condition of the horizontal stage. This allows the power supply to be checked stage by stage until the fault is located.

But there is a point to watch here. If the rest of the set is not drawing current, the over-voltage network consisting of TR908 & TR909 will shut everything down. This can be prevented by temporarily disconnecting R941.

A simpler trick is to repeatedly switch the set on and off, to activate the kick-start system, and use a CRO (ideally a storage type) to check for the pulses, stage by stage, up to TR906. This was what I did and I managed to confirm that TR906 was indeed receiving these pulses.

Murphy's lunch

By now, of course, the set was running again. The next time it failed, I again reverted to the jumper lead/Variac setup. And that clinched it; the set refused to run. The fault was not in the power supply. (At long last I had caught Murphy out at lunch).

I restored the power supply to its normal configuration, then moved over to the horizontal system. Unfortunately, we don't have sufficient space to reproduce the circuit, which is quite extensive. It involves two separate PC boards; the Deflection Chassis Board and the Deflection Output Chassis Board. The horizontal oscillator (TR703) is on the first board, while the driver stage (TR704) and the output stage (TR707) are on the second board.

One of the nasty aspects of this part of the set is the mechanical setup. The Deflection Output Board is mounted vertically on the right hand side of the set, copper side out. And mounted on the copper side, supported on spacers, is a large heatsink carrying the output transistor, TR707.

This creates a problem because all solder joints under this heatsink are completely inaccessible. And at least two components in this area, R721 and R722 in the base circuit of the horizontal driver transistor (TR704), have a reputation for dry joints.

Another item obscured by this heatsink is a wire-wrap pin inserted from the component side and soldered to the copper pattern. The wire-wrap lead from it runs to a similar wire-wrap pin on the Deflection Chassis Board. From here, the circuit runs to the collector of TR703, the horizontal oscillator.

All of which is by way of background. Having exonerated the power supply, I connected one CRO lead to the collector of the horizontal oscillator (TR903) and another to the base of the driver transistor (TR704). I then switched the set on several times to active the kick-start circuit. This produced a brief burst of voltage on the HT rail, sufficient to active the horizontal oscillator and produce a short burst of oscillation. So far so good.

But there was nothing at the base of TR704; the fault was between these two points. I was getting closer but the exact cause still had to be found. And considering its intermittent nature, it still looked like there was a long haul ahead.

I lifted the heatsink clear of the board and made a visual check of the path, joint by joint. Each appeared to be perfect but since this was obviously not the case, I went over each one and resoldered it. That done, I did the same around the oscillator section, involving TR703.

And that was it; the set hasn't missed a beat since, which was something of an anti-climax. Which joint was it? I can't be sure but I strongly suspect one or both of the wire-wrap pin joints; mainly because the solder seemed to come away from these much too readily.

And the TC53L2 set? It had a very common fault involving the over-voltage protection circuit, TR908 and TR909. I replaced both transistors and that was it. SC

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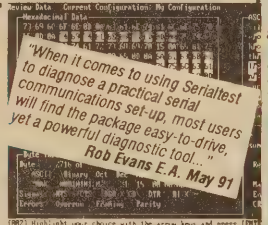
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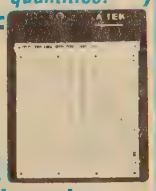

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An error analyser for CD players, Pt.2

This month, we present the second in a series of articles describing a CD error analyser. We have a look at the various Philips CD chipsets in use and describe the circuit of the analyser.

By STEPHEN McBRIDE*

As mentioned last month, this description is based on the Philips chipsets though the bulk of the information will also apply to most other brands. The various Philips chipsets are as follows: CD1 uses the SAA70x0 set with two TDA1540 14-bit D/A converters; CD2 uses the SAA7210 and SAA7220 with the TDA1541 twin 16-bit DAC; CD3 uses the SAA7310 and SAA7220 with the TDA1541 twin 16-bit DAC; CD3a uses the SAA7310 and SAA7320 Bit Stream Modulation system; and CD4 uses the SAA7310, SAA7220 and the SAA7320 Bit Stream system.

If we were to describe all the differences between the various chipsets, we would have to present an entirely separate article. What concerns us here is the standard error correction format used in all CD players. The key process is CIRC (Cross Interleaved Reed-Solomon Code - as defined last month).

A CD player in action

A CD player uses servo controllers to position the laser assembly under the spiral track of pits and lands. As the disc rotates, the photodiodes produce a signal which is amplified and then fed through a high pass filter to produce the HF signal. The HF is fed into the DEMOD circuit. DEMOD has its own PLL oscillator which runs in sync

with the incoming HF signal which may fluctuate in frequency slightly.

Then there are several blocks of processing with the end result being the recreation of the original bit clock and extraction of the subcode, audio and parity information, and frame and block sync signals. DEMOD also provides EFM decoding and outputs subcoding, clock signals and the audio data stream. (Note: this terminology was explained in last month's article).

The audio symbols are clocked into a shift register in ERCO at a rate set by DEMOD. Once a complete frame has been passed, (ie, 32 symbols), DEMOD signals ERCO that it has filled ERCO's input buffer. DEMOD then goes about extracting the next frame from the HF signal. ERCO quickly moves the new frame into an area of RAM to await further processing. When ERCO is ready for the next frame, it clocks it out of RAM at its own quartz crystal derived clock frequency.

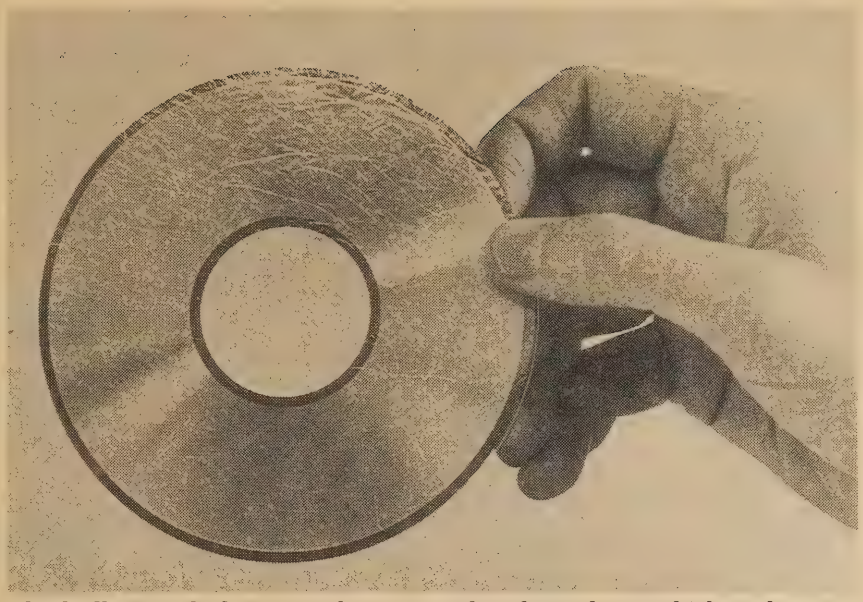
No wow and flutter

Since the audio data is fed through the ERCO process in a different timespan to when DEMOD read it, and its propagation is timed by a very accurate timebase, the PCM audio data emerging from ERCO is free from any fluctuations in speed that DEMOD may be experiencing or causing. So, because of the RAM buffering, the audio data stream is completely free of wow and flutter.

ERCO de-interleaves the data and performs CIRC error correction on all audio symbols and uses parity blocks to locate erasure corrections (an erasure correction is an erroneous symbol whose precise location is known). Once ERCO has finished its work, it serially clocks out the audio data to the interpolator and muting section, CIM. If ERCO is unable to correct all symbols, the erroneous ones are marked with a flag.

For the SAA7000 CIM, single errors are interpolated and multiple error bursts are muted (see definition in last month's article). ERCO generates a UNEC flag to mark the errors. The position of the UNEC flag in relation to the clock pulse tells CIM whether to interpolate or mute.

In the event of mute action being needed, ERCO gives CIM a 5-frame advance warning that an error burst is about to be sent through.



This badly scratched compact disc was used to obtain the very high readings shown in the photograph on the facing page. Normally, the readings from a 'clean' CD would be nowhere near this high.

The SAA7210 and SAA7310 perform basic (single symbol) interpolation internally. If a multiple burst occurs, they hold the last known valid value until the errors pass and then interpolate the last two values prior to the valid data returning. In either case, they both generate a flag, EFAB, to signal to the SAA7220 (if fitted) that further action should be taken. The SAA7220 has the ability to enhance the error handling capabilities by providing linear interpolation of up to eight consecutive errors. EFAB tells it where it needs to act.

After the CIM section, the data stream is fed into a digital transversal filter where it undergoes 4x oversampling, stepping up the effective sampling rate from 44.1kHz to 176.4kHz.

After oversampling and digital filtering, the signal is moved to the D/A converters which convert the two's complement, 16-bit audio samples into an analog current. A current to voltage converter follows, then finally a third order Bessel filter to remove any unwanted harmonics. Some players also have a de-emphasis circuit incorporated into the I-V converter whose action is controlled by a signal from the decoder.

In addition to its audio symbol manipulation, ERCO also generates a PWM (Pulse Width Modulation) signal called MCES (Motor speed Control, Erco to Servo) which is obtained by subtracting the current write address pointer from the current read address pointer of the CIRC storage RAM. If the memory is 50% full, the PWM signal runs at a duty cycle of 50%. If the memory is greater or less than 50% full, the duty cycle changes to alter the disc turntable motor speed, thus increasing or decreasing the data flow rate into the RAM buffer.

This system allows the RAM to stay around 50% full, thus giving maximum data buffering capabilities between the data coming from the disc and the quartz oscillator clocked data leaving ERCO. From the time audio data leaves ERCO right up to the point of D/A conversion, the propagation rate in all stages is controlled by clock signals derived from the master quartz based oscillator, hence no wow and flutter, etc. Philips was the first to use digital speed control for the disc motor and most other companies have now followed suit.

The SAA7320 is radically different. It uses a 256-times oversampling digital filter and creates a 1-bit PDM (Pulse Density Modulation) signal which feeds a 1-bit DAC running at a 11.2896MHz; ie, 191.9232 Mbit/s. And you thought your PC worked hard!

This 'Bit Stream Modulation' offers certain advantages over conventional DACs - in particular, better linearity at low signal levels, where 16-bit DACs perform poorly. The operation of Bit Stream Processors requires a some-

what lengthy explanation which I won't cover here as it's not important to the project.

How the error analyser works

The CD Error Analyser (CDEA) has two 7-segment displays to count the number of data dropouts and interpolations which have occurred during playback of a compact disc. Both counters operate on a real time basis; ie, the counters are incremented as the events occur. Both displays have four digits but there are facilities to extend the interpolation counters to five or six digits if so desired. Overflow indicators flash if the number of detected events exceeds the counter's capabilities.

The counters ignore errors which occur during track searching as these are not faults.

Why have extra digits on the interpolation counters? Well, more than 9999 dropouts on a disc is rare and indicates the disc is in urgent need of cleaning, but one sizeable dropout can cause thousands of interpolation errors; ie, it could overflow the interpolation counters very quickly. A 6-digit display needs 1,000,000 counts to overflow it. Both the main and display PC boards have facilities for 4, 5 or 6-digit configurations. Other niceties include automatic resetting of the counters at the start of play and remote power on/off controlled by the CD player's power switch.

The CDEA has three PC boards: a main board and a display board which mount at right angles to each other and are housed in a low profile instrument case. The third PC board is a small satellite board fitted inside the CD player. This board acts as a buffer to prevent loading of the player's digital circuits by the cable to the CDEA unit. It also has facilities to configure the unit to suit the logic levels and phase (normally high or low) of the CD player's circuitry. Details on how to configure this PC board to suit your

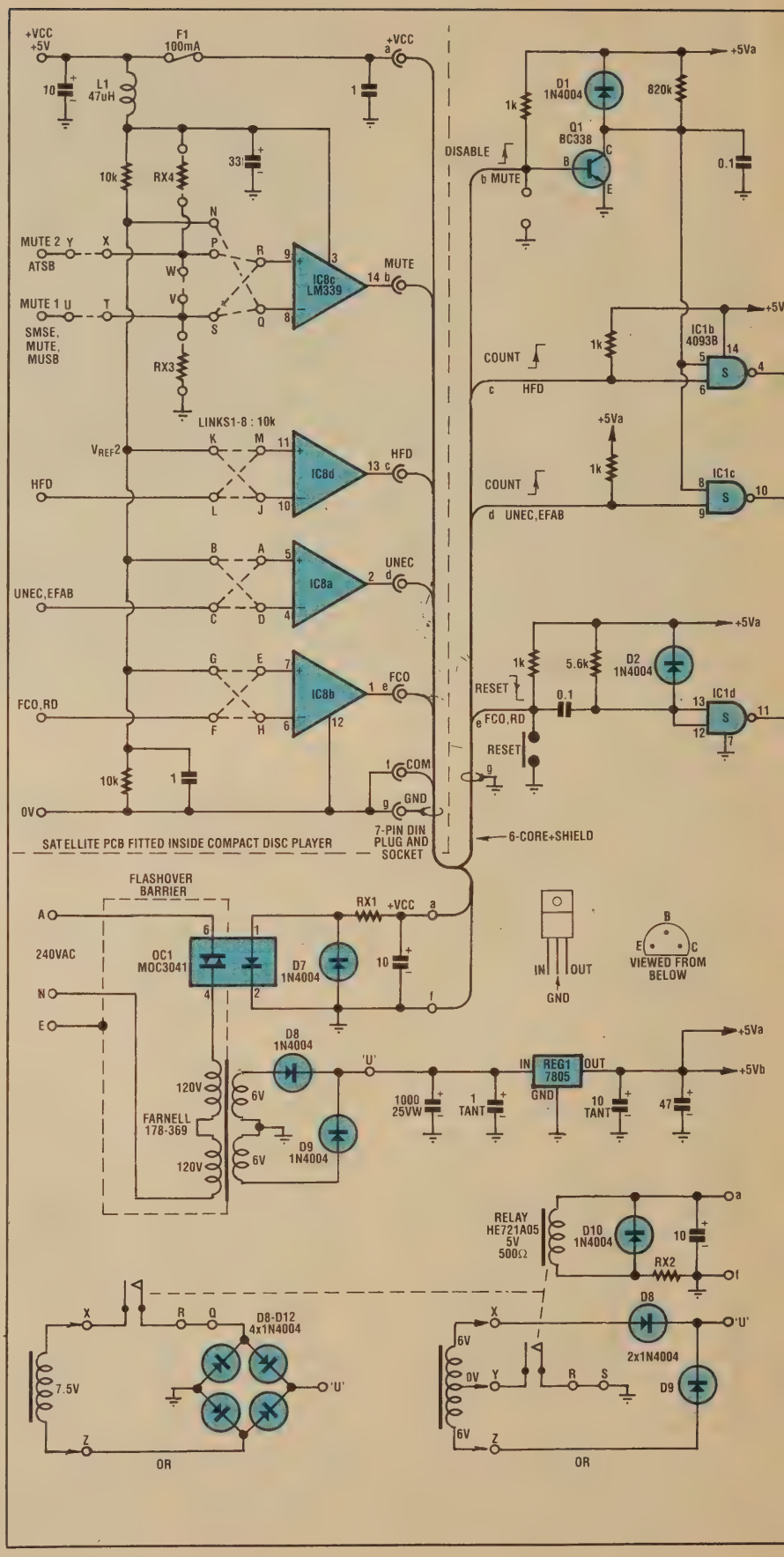
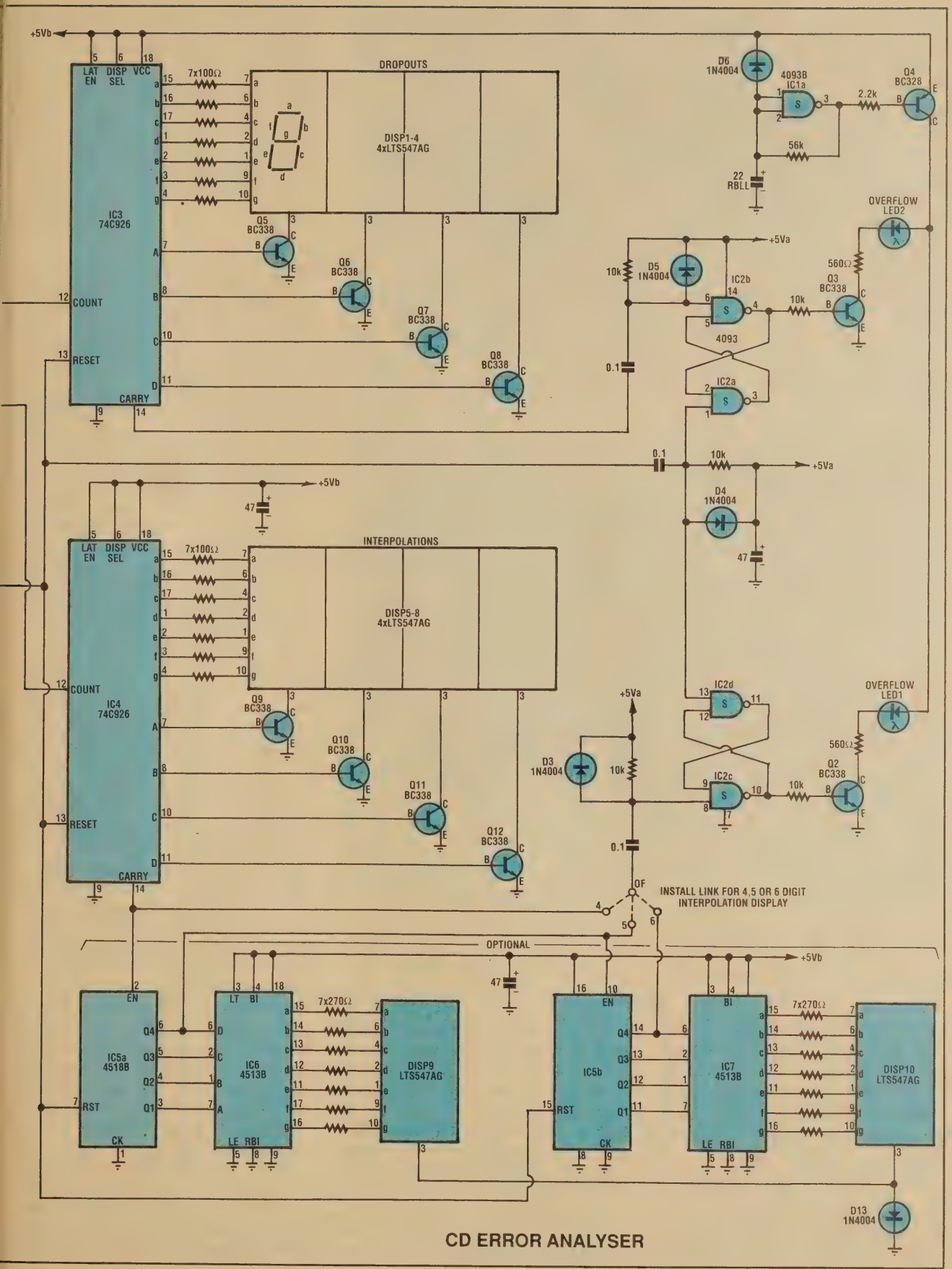
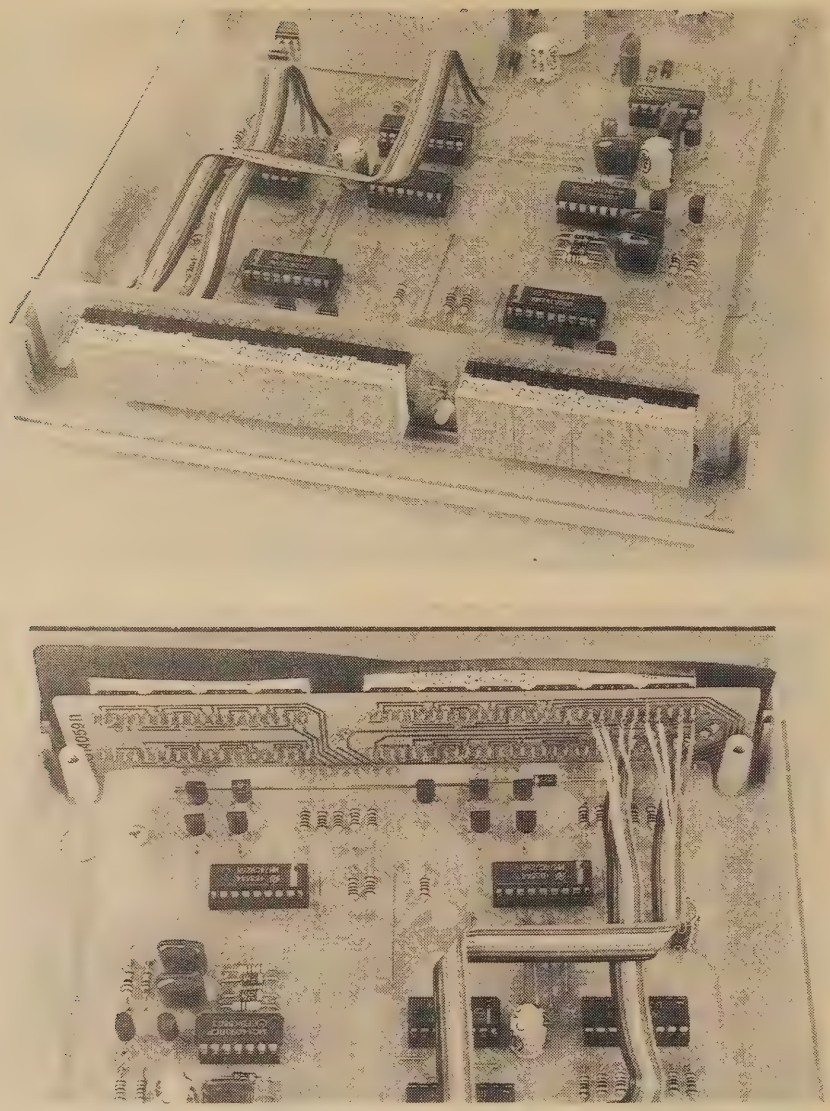


Fig.2: the circuit for the CD Error Analyser is fairly straightforward. IC8a-IC8c provide the interfacing to the CD player & drive two 74C926 4-digit counters (IC3 & IC4) via NAND gates IC1b-IC1d. IC5, IC6 & IC7 provide an opuonal 5 or 6-digit readout for the interpolation display.



CD ERROR ANALYSER



The display board carries the 7-segment LED readouts & the two overflow indicator LEDs. Note that the prototype included the optional extra circuitry to obtain a 6-digit readout for the interpolation display.

machine are given later in this series.

Now refer to the circuit diagram which is quite large but relatively uncomplicated - see Fig.2. It consists of an input conditioner, gating network, counters and power supply.

Input conditioner board

Most chipsets are fabricated with MOS technology (CD1 is NMOS) which isn't capable of driving the reactive load of a multicore cable. Thus, an input conditioning board is used to act as a line driver/buffer.

IC8 is an LM339 quad high speed quad comparator with open collector (O/C) outputs. Each comparator section is used in an exclusive OR gate mode. This is done by connecting the inverting or non-inverting input to a reference voltage which is fixed at half the supply voltage (ie, +2.5V for 5V logic), while the other input is connected to specified logic lines in the CD player.

By swapping the connections to the two input pins, the comparator can be used as an inverting or a non-inverting buffer so it can be set to suit normally high or normally low data signals as inputs.

This means that if configured correctly, the signals leaving the conditioning board will be the same for all players regardless of which chipset is used.

The conditioner PC board connects to the same regulated DC supply as the CD player's decoder circuitry, which is usually +5V DC. The circuit only draws about 20mA from the CD player, the bulk of which drives the LED in an optocoupled Triac, or a reed relay coil (more on this soon). A 100mA fuse (F1) protects the CD player from any cable faults. Inductor L1 and the associated 33µF capacitor form a filter to reduce interference from the crystal oscillator circuits in the player.

Satellite board signals

Four control line connections are made from the CD player to the satellite board. The first is the HFD line which indicates that a dropout has occurred. The HFD line is connected to comparator IC8d and sent to pin 6 of IC1b (on the main board). If pin 5 of IC1b is high, the HFD pulse will be fed via NAND gate IC1b to pin 12 of IC3, a 4-digit counter. Hence we have a count of the dropouts as they occur.

Similarly, the UNEC line indicates that an interpolation has occurred. It is connected to comparator IC8d and sent to pin 9 of IC1c on the main board. From there it goes to pin 12 of IC4, another 4-digit counter. This gives a count of the interpolations.

The third control line is FC0 which is connected to comparator IC8b. When the player is in the stop mode, this line is high, and it goes low during the startup procedure. At the end of a disc, it returns high. The high to low transition only occurs during the initial starting up of a disc from stationary. When it does so, pin 1 of IC8b pulls low. This momentarily pulls the input to IC1d low (via the 0.1µF capacitor), causing the output (pin 11) of IC1d to go high.

This resets all the counters to zero and clears the overflow latches, IC2a-d. So the counters are automatically reset when a disc is started up from the stop mode.

The fourth and last control line is MUTE. Having a MUTE line is very convenient because as the laser skips across tracks during search operations, gross errors occur in the audio data stream. In fact, the C1 and C2 error syndrome generators in the CD player literally go berserk.

This would overflow the counters very rapidly but since these errors aren't 'fault' errors, we use the MUTE line to disable the counters, since MUTE is activated when the CD's

microprocessor expects errors to occur.

IC8c buffers the line and on MUTE being activated, it enables Q1 to turn on. This pulls pin 5 of IC1b and pin 8 of IC1c low, thus preventing these gates from passing through HFD and UNEC pulses to counters IC3 and IC4. So all pulses actually registered by the counters will be valid dropouts or interpolations.

Counters

There were several options to choose from for the counters. Single digit CMOS counters are cheap but take up a lot of space on the PC board. Multiplexed devices are more compact but are also more expensive. I decided to use National Semiconductor's MM74C926 4-digit counter. This device contains the whole works for a 4-digit multiplexed counter and only needs segment resistors and display driver transistors as external components.

The counters are RESET by a high on pin 13. They are incremented by negative-going pulses applied to their pin 12s. When the count reaches 9999, the next clock pulse sets the CARRY output, pin 14, from high to low which toggles the two RS flipflops comprised of the 4093 quad NAND gate package, IC2.

Overflow indication

IC1a is a square wave generator which turns Q4 on and off at a frequency of about 1Hz. When a CARRY signal appears at the output of IC3 or IC4, the associated RS flipflop (IC2a,2b or IC2c,2d) toggles and turns on Q2 or Q3. This allows the pulsing voltage from the collector of transistor Q4 to pass a current through overflow LED 1 or LED 2 so they will blink.

When the reset line from pin 11 of IC1d goes high and clears the counters, the CARRY outputs go low. If the counter is in the range 6000-9999, CARRY will be high, so if RESET occurs here, CARRY will be forced low and thus toggle the RS flipflops. However, as the RESET line goes low, the 0.1µF capacitor on pins 1 & 13 of IC2 couples through a brief negative pulse which again toggles the flipflops, thus overcoming the problem.

5 or 6-digit display

If a 5 or 6-digit display is desired, the additional components shown at the bottom righthand corner of the circuit are used. The chips involved are a 4518 dual BCD up counter (IC5) and two 4513 BCD to 7-segment decoder/drivers (IC6 & IC7).

The CARRY output of IC4 is used to clock pin 2 of IC5a. The '8' output of IC5a is then used to clock pin 10 of counter IC5b. The '8' outputs of both IC5a (pin 6) or IC5b (pin 14) are used to generate an overflow pulse for a 5 or 6-digit readout respectively, and a link on the main PC board is placed in one of three holes to determine the number of digits. The BCD outputs go to IC6 and IC7, the 4513 BCD to 7-segment decoder/drivers, which directly drive the LED displays through 270Ω current limiting resistors, one for each segment.

Why did we use 4513s instead of 4511, 4543, 4056 or 4026s? The 4543, 4026 and 4056 have high sink capabilities but poor source currents at 5V, so they would need a bank of driver transistors to match the drive currents of the 74C926. The 4511 has the drive but doesn't put the tails on a 6 or 9 so it displays them as a 'b' and 'q' respectively. The 4513, however, gives full 6's and 9's at up to 20mA at 5V and so is the ideal choice.

PARTS LIST

1 12V centre-tapped mains transformer (Farnell Cat. 178-369, see text)
1 neutral gray acrylic filter (Farnell Cat 178-186)
1 instrument case, 180 x 230 x 40mm (Jaycar Cat. HB-5915)
1 PC board, code SC01405911
1 PC board, code SC01405912
1 PC board, code SC01405913
1 47µH inductor (L1)
1 100mA M205 quick blow fuse
2 M205 PC fuse clips
4 PC stakes
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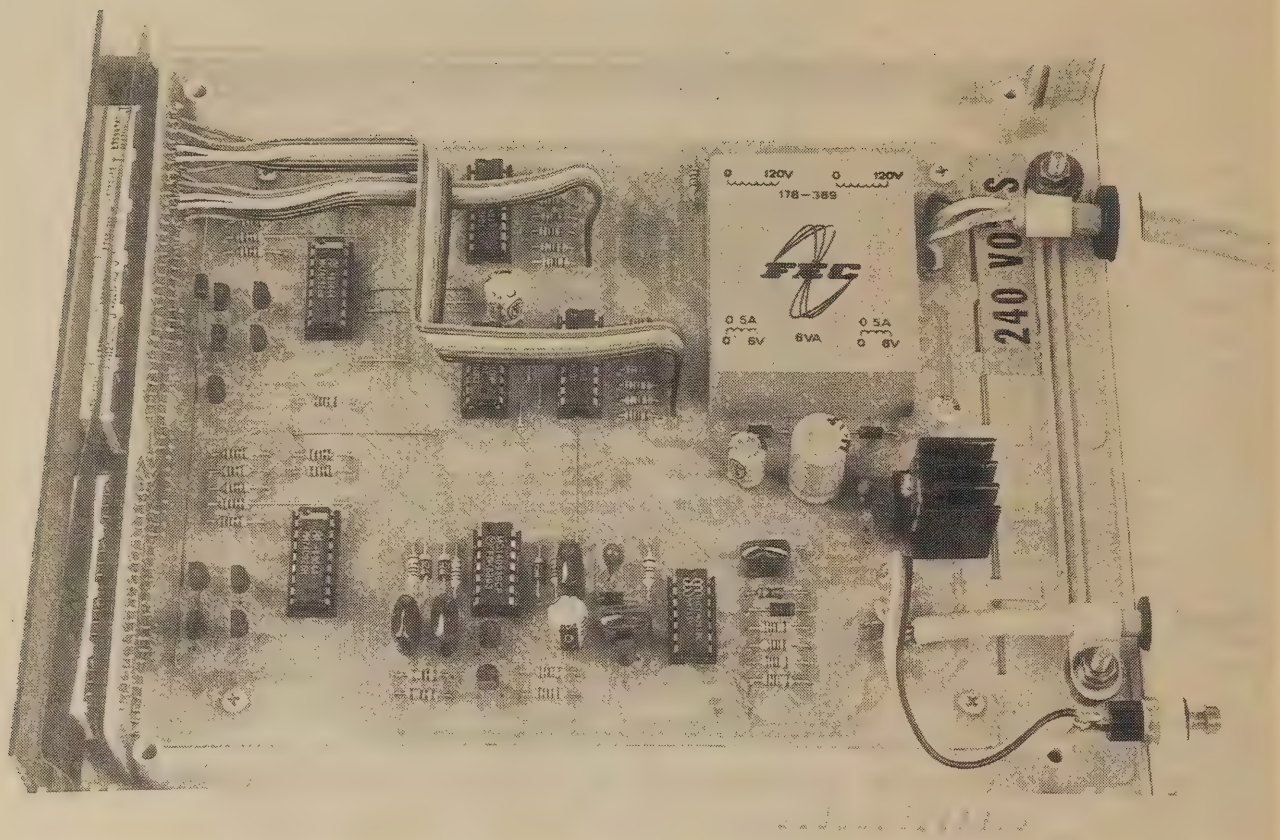
1 16-pin DIL IC sockets
2 14-pin DIL IC sockets
1 4-way right angle 0.1-inch pin launcher (Jaycar Cat. HM-3214)
3 8-way right angle 0.1-inch pin launchers (Jaycar Cat. HM-3215)
1 PC-mounting heatsink (DSE Cat. H-3490)
2 rubber grommets
2 cable clamps
4 rubber feet
1 7-pin DIN plug & socket
1 500mm-length of rainbow cable
1 240VAC plug & cable
1 1-metre length of 6-core shielded cable

Semiconductors
2 4093B quad NAND Schmitt trigger gates (IC1,IC2)
2 74C926 4-digit decade counters (IC3,IC4)
1 4518B dual BCD up counter (IC5; optional)
2 4513B 7-segment decoder/drivers (IC6,IC7; optional)
1 LM339 quad comparator (IC8)
1 MOC3041 zero-crossing optocoupled Triac (OC1)
1 7805 +5V voltage regulator (REG1)
11 BC338 NPN transistors (Q1-3, Q5-12)
1 BC328 PNP transistor (Q4)
10 1N4004 diodes (D1-9,D13)
10 LTS547AG 0.52-inch green 7-segment common cathode LED displays
2 3mm green LEDs (LED1,2)

Capacitors
1 1000µF 25VW PC electrolytic
4 47µF 16VW PC electrolytics
1 33µF 10VW PC electrolytics
1 22µF 16VW PC electrolytics
2 10µF 16VW PC electrolytics
1 10µF 16VW tantalum
3 1µF 16VW tantalum
5 0.1µF metallised polyester (greencap)

Resistors (0.25W, 5%)
1 820kΩ
1 56kΩ
15 10kΩ
1 5.6kΩ
1 2.2kΩ
4 1kΩ
2 560Ω
14 270Ω
14 100Ω

Miscellaneous
Spacers, screws & nuts, tinned copper wire, solder, heatsink compound, adhesive labelling.



Most of the circuitry is mounted on two PC boards which are soldered together at right angles, while a third interface board mounts inside the CD player. Full construction details will be published next month, together with the interfacing details for players using Philips chipsets.

The LED displays used in the prototype are Litton LTS547AG's, a green common-cathode, high intensity 0.52-inch unit sourced from Adilam Electronics. Hewlett Packard has a comparable but more expensive device, the HDSP5603. Priced midway is the Senior SEC5612 which is available from Panel Parts.

Green displays were used because most CD players have a blue-green fluorescent display, so the CDEA will complement it. Red displays such as FND500, LTS547AP or HDSP5303 can be used but will have a reduced brightness and in any case, red displays look less attractive.

Power supply

To make the project as universal as possible, there are several power supply options available. The recommended way is a small PCB-mounted 5VA transformer from Farnell Electronics, as shown on the circuit diagram. A +5V DC rail comes from the CD player via fuse F1 to drive the LED in OC1, a MOC3041 zero-voltage switching optocoupled Triac.

When the CD player is turned on, a 20mA current flows through F1 and the LED in OC1. This turns on the Triac, thus supplying 240VAC to the transformer primary. RX1 limits the current from the CD player's power supply and the associated 10µF capacitor bypasses transients. (For RX1, use 150Ω for +5V, 330Ω for +9V and 470Ω for +12V).

So we have an on/off power control slaved from the CD player's power supply. The MOC3041 keeps the mains supply well away from the CD player's circuits.

The dual 6V secondaries are connected via diodes D8 and D9 which form a fullwave rectifier to feed a 1000µF filter capacitor. This supplies a 3-terminal regulator, REG1, to provide a +5V DC supply to the circuit. There are numerous bypass capacitors placed strategically around the PC board as well.

Alternatively, you may wish to power the unit from a freestanding transformer or a plugpack (AC or DC). The PC board has the facilities to take any of these, using either a fullwave bridge (single winding) or fullwave centre-tapped (or dual secondaries) format. A miniature reed relay is used to switch the secondary current because we are only switching low voltages and an optocoupler can't be used.

Resistor RX2 is used to feed the miniature reed relay's coil. If the CD player's control voltage is +5V, the resistor is not required. For a voltage of +9V, the resistor is 390Ω and for +12V, 680Ω.

Next month, we shall complete the presentation of the CD error analyser and show how to connect it to typical CD players. **SC**

* Stud. I.E. Aust; Dept. of Electronic and Computer Engineering, James Cook University, Townsville.

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The Story of Electrical Energy, Pt.12

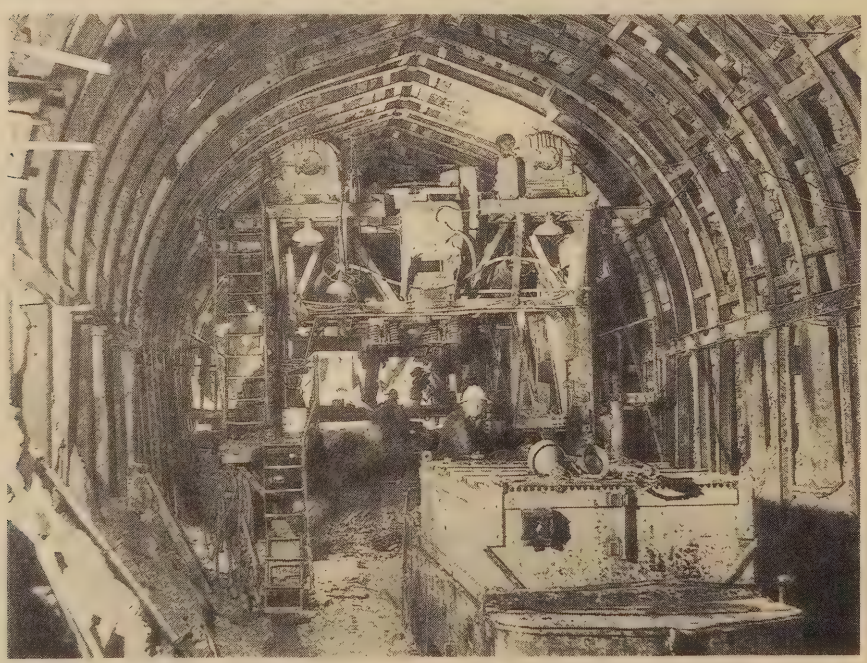
The first major sections of the Snowy Mountains Hydroelectric scheme to come on line were all underground. Huge caverns and tunnels had to be carved out of the mountains & mammoth electrical machinery installed.

By BRYAN MAHER

A shining example of the design ingenuity and the enormous size of the Snowy Mountains Hydroelectric project becomes apparent when we look at the Eucumbene-Tumut tunnel construction. Its complexity is typified in the control of water flow in two directions through the system.

Twenty two kilometres in length, this is the longest tunnel in the scheme. Bored right through the Great Dividing Range, in places as much as 520 metres below the massif above, this tunnel traverses the worst fault zones found in these mountains.

Excavated throughout its length to a diameter of 6.9 metres (22 feet 6.7 inches), the tunnel was steel and concrete lined in regions of vertical faults and possible ground movement. This lining extends over 28% of the length of the tunnel.



Taken during the construction of the Eucumbene Tumut tunnel, this photo shows the heavy bracing installed before it was lined with concrete. In the foreground is a battery-operated locomotive which was used for transporting men and equipment.

The first step in lining the tunnel was to install massive 250 x 125mm structural steel ribs. In the most critical sections, a cage structure of steel reinforcing rods was welded to the ribs and then the final concrete lining was sprayed on to form the finished tunnel walls.

Because of its smooth bore, 6.4 metres in diameter, the concrete lined tunnel carries the 114m^3/sec water flow as easily as the larger rough walled unlined sections. It's interesting to note that the 1-metre gauge railway tracks, used during construction to carry men and materials, still run down the centre of the finished tunnel floor.

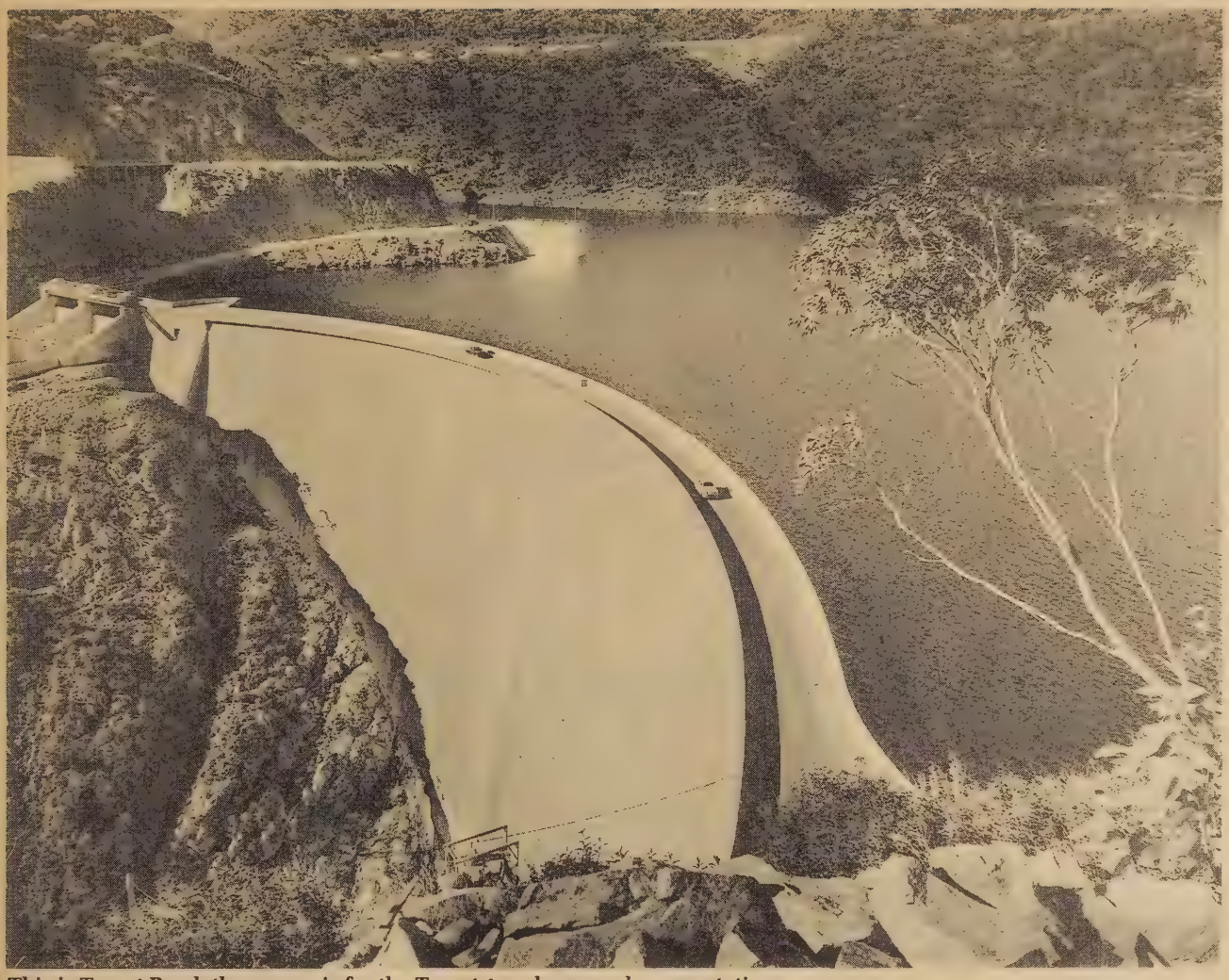
The diagrams of Fig.1 show the Eucumbene-Tumut tunnel and the Happy Jacks Junction. A huge bulkhead gate, together with a guard gate, each 6.4 x 3.91 metres, controls the water flow at the Lake Eucumbene portal.

Similar hydraulically operated gates are installed at the Tumut Pond outlet structure. Fine control of the flow rate is achieved by a 6.4 x 3.9-metre regulating gate mounted back in the tunnel.

The Eucumbene-Tumut tunnel passes approximately 100 metres below the confluence of the Happy Jack and Upper Tumut rivers. Here a small dam forms a pondage. From its floor, a 5.5-metre diameter vertical shaft brings water down to join the main east-west tunnel. Flow from Happy Jack is then regulated by a 6.2-metre gate valve.

Siphon intakes

Siphon intakes, whereby water can be collected by tunnels from rivers under which they pass, are used extensively in the Snowy. Up to 20



This is Tumut Pond, the reservoir for the Tumut 1 underground power station. It is held by an 86-metre high thin concrete arch dam which was completed in 1958. Tumut 1 was Australia's first underground power station.

siphons operate in sequential order, carrying water down to the tunnel below. The purpose of the siphon system is to prevent the intake from scavenging the total river flow in times of low rainfall.

As rain or snowmelt increases, more siphons automatically come into operation, conducting an increased share of the water down the shaft to the tunnel below - see Fig.2.

The reservoir providing the water head for Tumut 1 power station is Tumut Pond, high above in the mountains. Sitting astride a broad fault zone, this reservoir is held by an 86-metre high thin concrete arch dam. Holding 53 gigalitres of water at a height of 1158 metres above sea level, this dam was completed in 1958.

Thus, the Eucumbene-Tumut was the first transmountain section of the Snowy Scheme to be placed in service.

Underground power stations

A unique feature of the Snowy Hydroelectric scheme is the arrangement of two underground power stations in tandem. Fed in turn by essentially the same water, both power stations are buried deep within the granite mountains.

When it first came on line in December 1959, Tumut 1 ushered Australia into the age of underground power stations. Boasting the greatest water head for the day (292.6 metres), the four 82 megawatt Francis turbines were the first in operation on the western side of the scheme. Each turbine rotates at 375 RPM and drives a 16-pole alternator mounted immediately above it.

The machine hall was hewn from the mountain's interior, 415 metres below the surface. It is 93 metres across and 34 metres high and required the excavation of over 100,000 tonnes of rock. It is the equivalent of a large city building buried deep underground. Excavation commenced in May 1955 and the station was completed 4½ years later.

Pressure shafts

From Tumut Pond reservoir, the Tumut 1 pressure tunnel runs 2.4 kilometres north-westward through the mountain at a slight downward gradient. At 6.4 metres in diameter, this fully lined tunnel can carry as much as 125 tonnes of water per second.

At a point almost above the underground power station, the tunnel divides into two 3.66-metre steel lined shafts which drop 240 metres to feed the power station's four turbines. The water regulating valves at the power

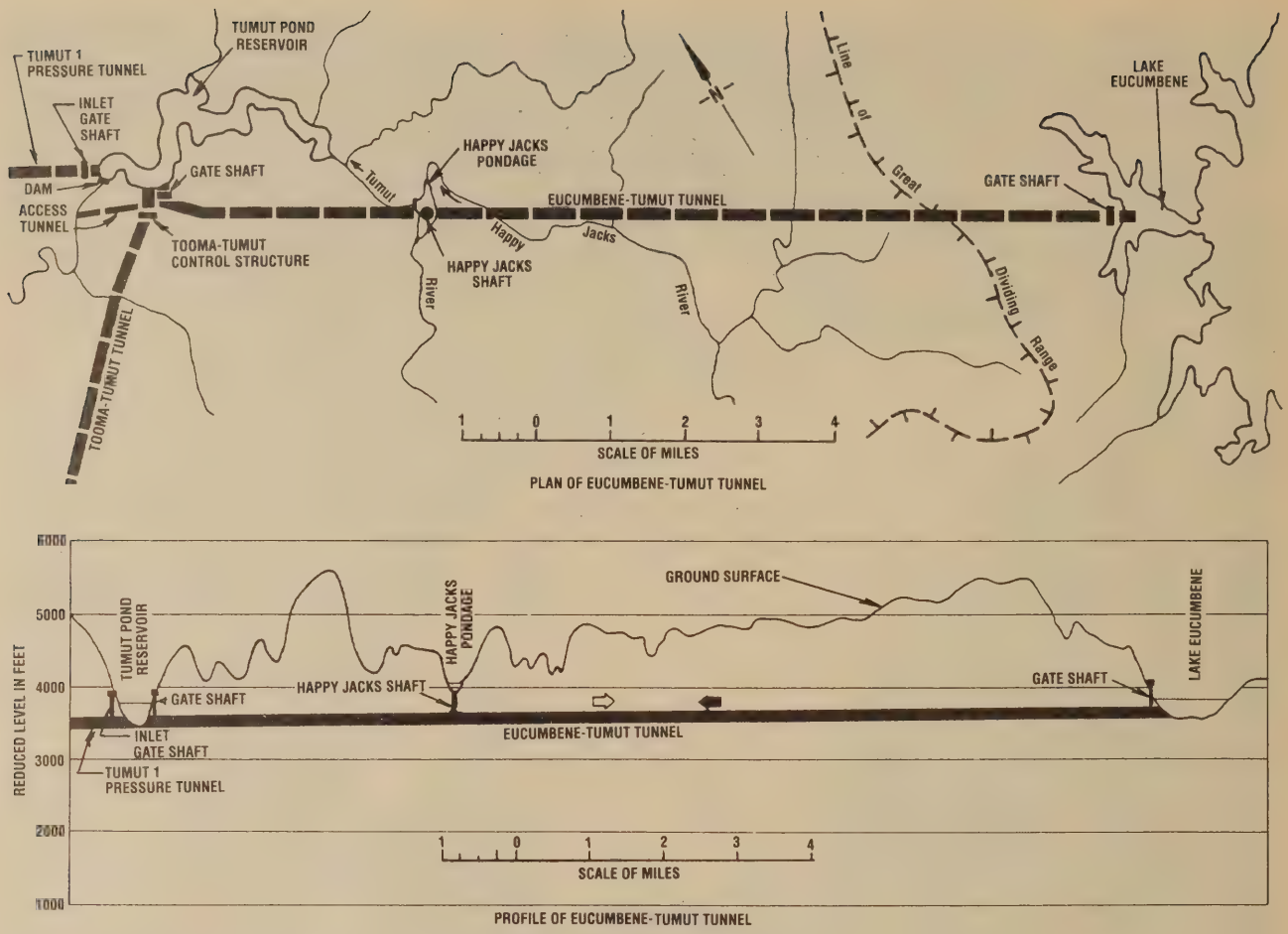


Fig.1: these diagrams show the plan and cross-section of the Eucumbene Tumut tunnel which can transport water in either of two directions between Lake Eucumbene & Tumut Pond Reservoir.

station are continually adjusted to control the turbines, as required by the varying electrical loading on the generators. At any partial or complete valve closure, the momentum of many thousands of tonnes of water rushing through the pressure tunnel must be safely controlled.

This is done with the aid of a very large surge chamber. As shown in Fig.3, two 5.5-metre diameter shafts rise 82 metres to a much larger chamber 15.3 metres in diameter and 40 metres high.

Electrical aspects

Many innovations in electrical engineering are to be found in the Snowy Scheme. The four 80 megawatt alternators at Tumut 1 each produce a 12.5kV 3700 amp 3-phase output. This must be stepped up to 330kV for transmission to the state grid system.

From the underground alternators, the shortest path to the aboveground high voltage switchyard is about 500 metres via the cable tunnel. This would be much too far to run the 12.5kV 3700 amp generator conductors because there would have been considerable resistance losses. Therefore, the 12.5kV/330kV step-up transformers were located underground in a chamber adjacent to and almost as large in floor area as the turbine hall.

The transformer bay contains seven single phase, oil filled, water cooled transformers. Each is mounted on flanged wheels. These fit a set of rails via which any transformer can be wheeled out to the assembly bay. Here access is available to the two 110/10-tonne capacity station cranes.

But why have seven single phase transformers when the four alternators have 3-phase output? The unusual setup means that six transformers are always connected, with one as a spare. Each transformer has two 12.5kV 28MVA primaries and one 191kV 56MVA secondary winding.

As the circuit diagram of Fig.4 illustrates, pairs of generators share one bank of three transformers to provide 330kV 3-phase output. The star connection of three 191kV secondaries produces a line-to-line voltage of 330kV (191kV x [sqrt]3 = 330kV). The delta primary connections, on the other hand, allow circulation of 3rd harmonic currents caused by the non-linearity of the transformer core permeability.

This delta connection is necessary as the three isolated iron cores do not allow 3rd harmonics in the magnetic flux to circulate between phases to stabilise the secondary neutral potential.

Output cables

The total output from Tumut 1 power station is carried by two 330kV 168MVA circuits. From the underground transformer hall, power is carried by six single core oil-filled paper insulated 330kV cables. These are laid within the cable tunnel to the surface.

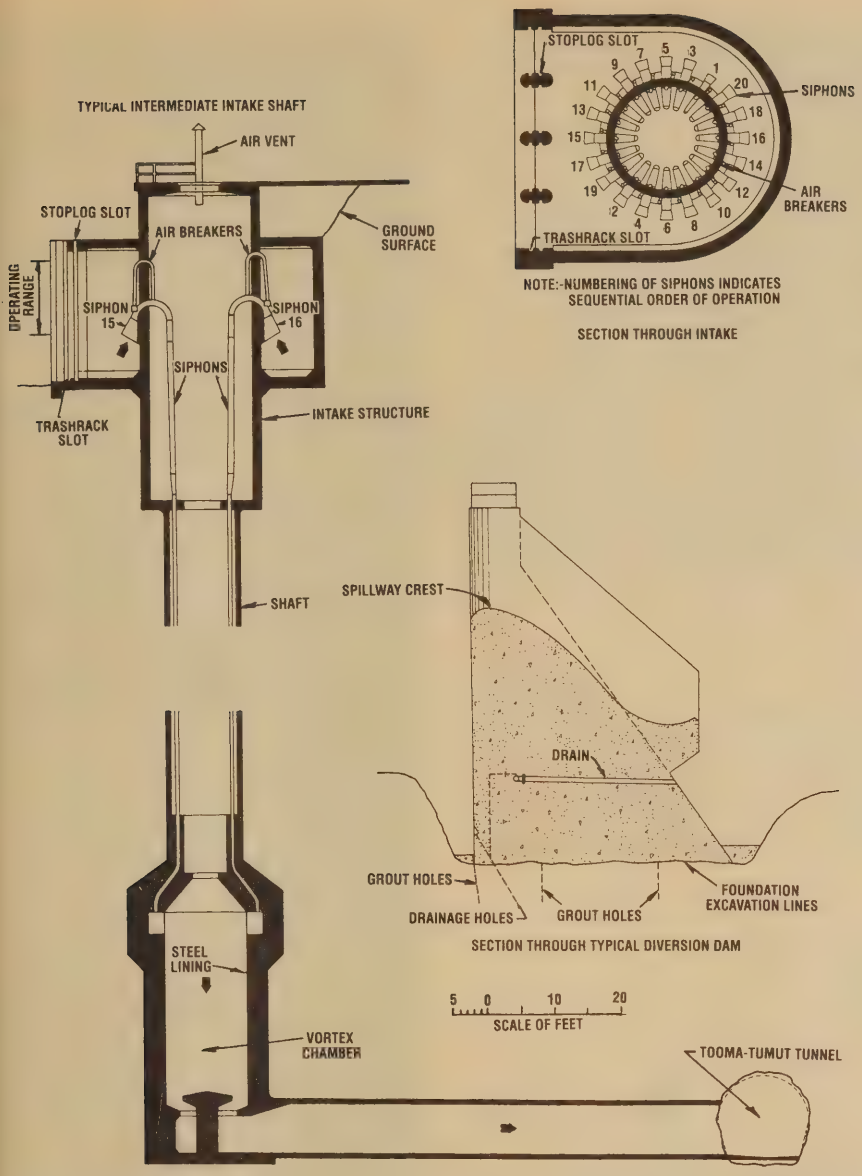


Fig.2: a typical siphon intake system, as used to take water from the Happy Jack River to the Eucumbene Tumut tunnel below. In this scheme, a system of up to 20 siphons comes into operation sequentially, depending on the height of water in the river.

From there, they run via by an arched bridge across the upper Tumut River gorge to the open air switchyard.

These high voltage single core cables in the cable tunnel cannot have steel armouring. If they did, the AC magnetic field produced by the currents in the cable would induce eddy currents in the steel sheath. These eddy currents would lead to huge losses, manifested as destructive heating of the cable sheath.

The electrical output from Tumut 1 power station ushered in the first 330kV substation on the NSW grid system. This was built at Yass in 1959, where seven 330/132kV transformers were installed.

Second use of the water

Having done its work in Tumut 1, the water exiting from the four turbines flows via the tailwater tunnel to Tumut 2 power station. With a width of 8.53 metres and height of 7.7 metres, this horseshoe section tailwater tunnel has the largest cross sectional area of any tunnel in the Snowy system.

So large is the interior volume of this tunnel, that four Sydney suburban trains could fit in together; two

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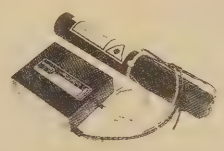

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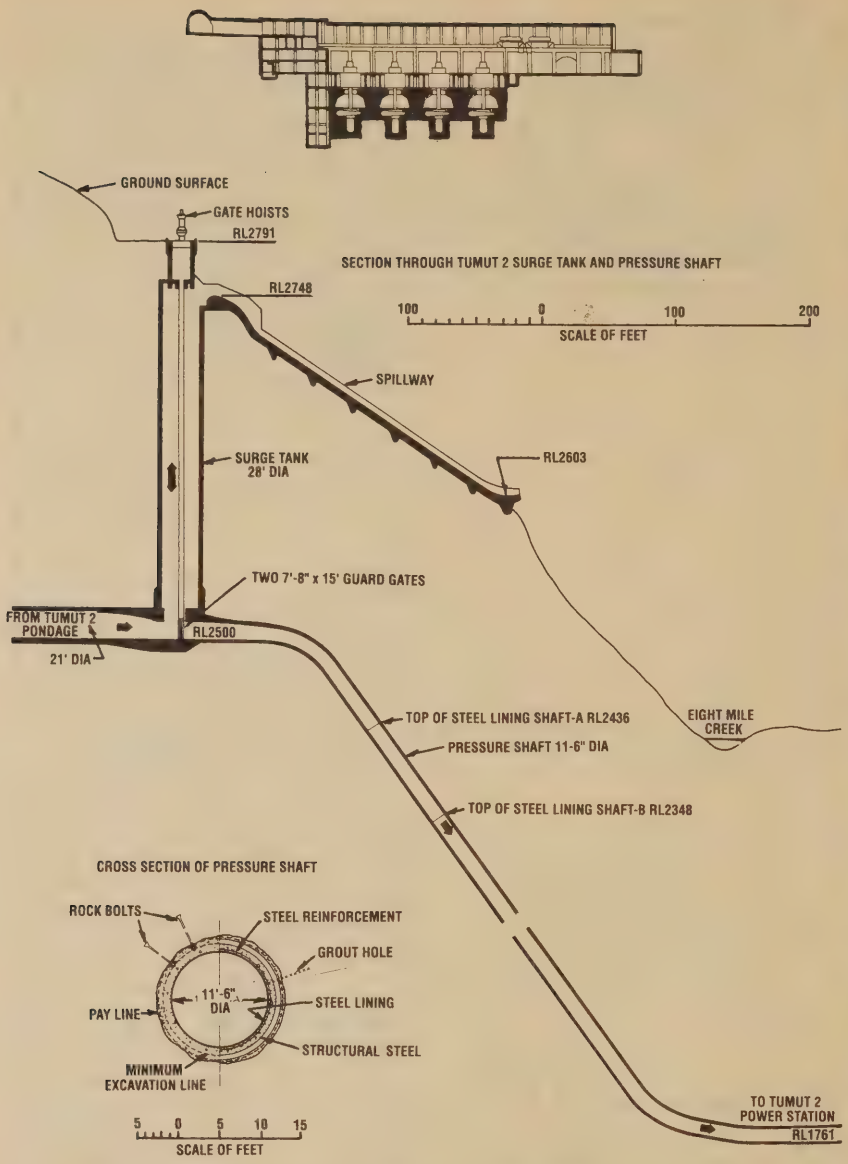


Fig.3: the surge chamber used for Tumut 2 power station. Surge chambers are there to stop the equivalent of "water hammer" in the pressure shafts feeding the turbines. When the water is shut off or reduced in flow, the surge chamber prevents a huge rise in water pressure which would otherwise occur due to the momentum of thousands of tonnes of water moving at high speed.

abreast and stacked two high! This huge 300 metre length of tunnel forms the lower surge chamber.

Tandem underground stations

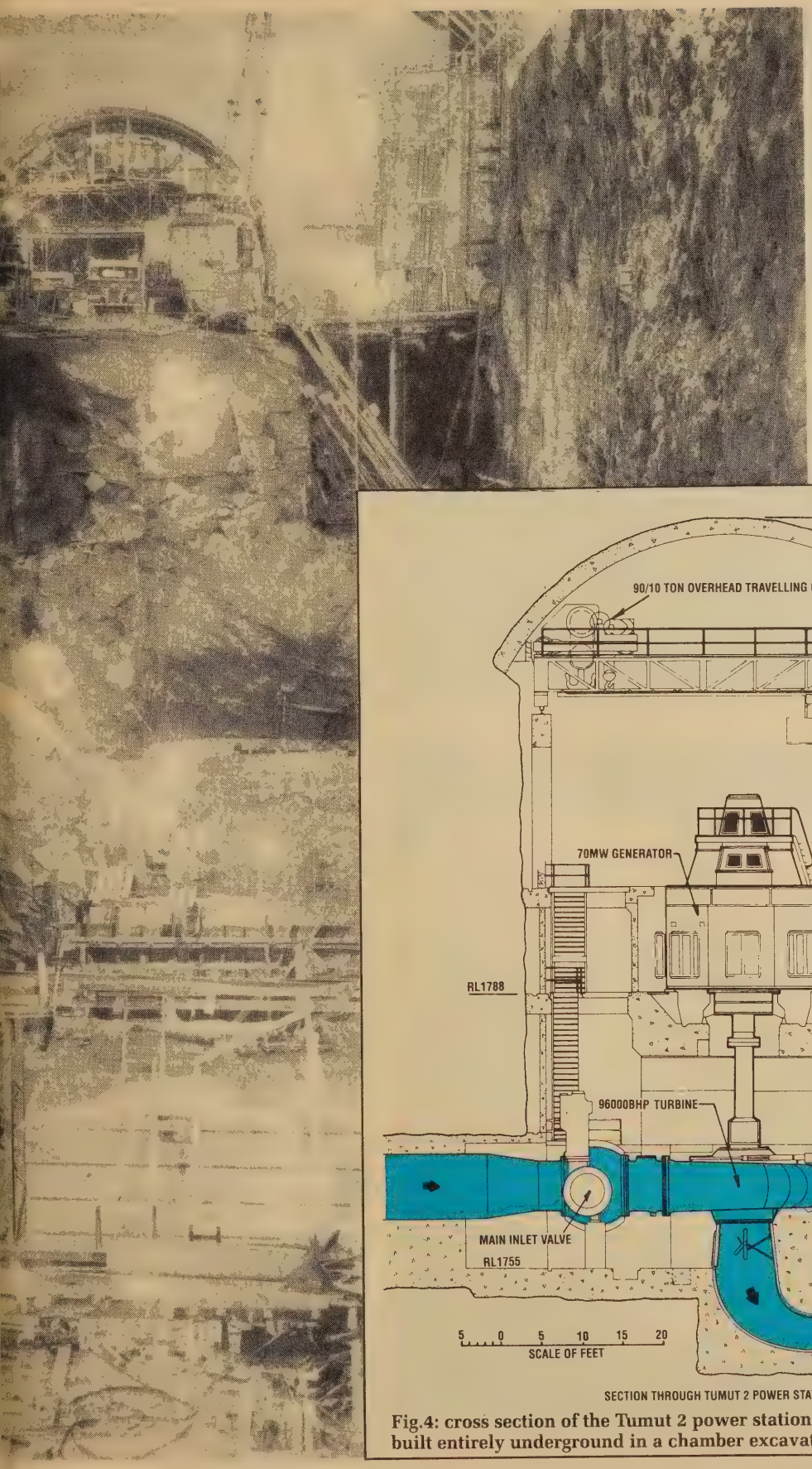
It is indeed unusual to find a tandem arrangement of underground power stations. Yet that is the way Tumut 1 and Tumut 2 are constructed.

The Tumut 1 tailwater tunnel discharges into Tumut 2 pondage. This is a small surface holding stage in a cleft of the mountains, 20 hectares in area, held by a very small concrete dam 46 metres high. From this pondage, a second pressure tunnel carries the water 4.8 kilometres through the mountains to Tumut 2 power station.

Above Tumut 2 the pressure tunnel divides into two steel lined downcomer shafts. These slope downwards 230 metres to feed water to the four 71.6MW turbines.

Water equalization

Normally, both Tumut 1 and Tumut 2 stations use exactly the same water flow. But provision must be made in the design for possible load shedding



Left: Tumut 1 power station during the excavation stage, in the mid-1950s. This was Australia's first underground power station.

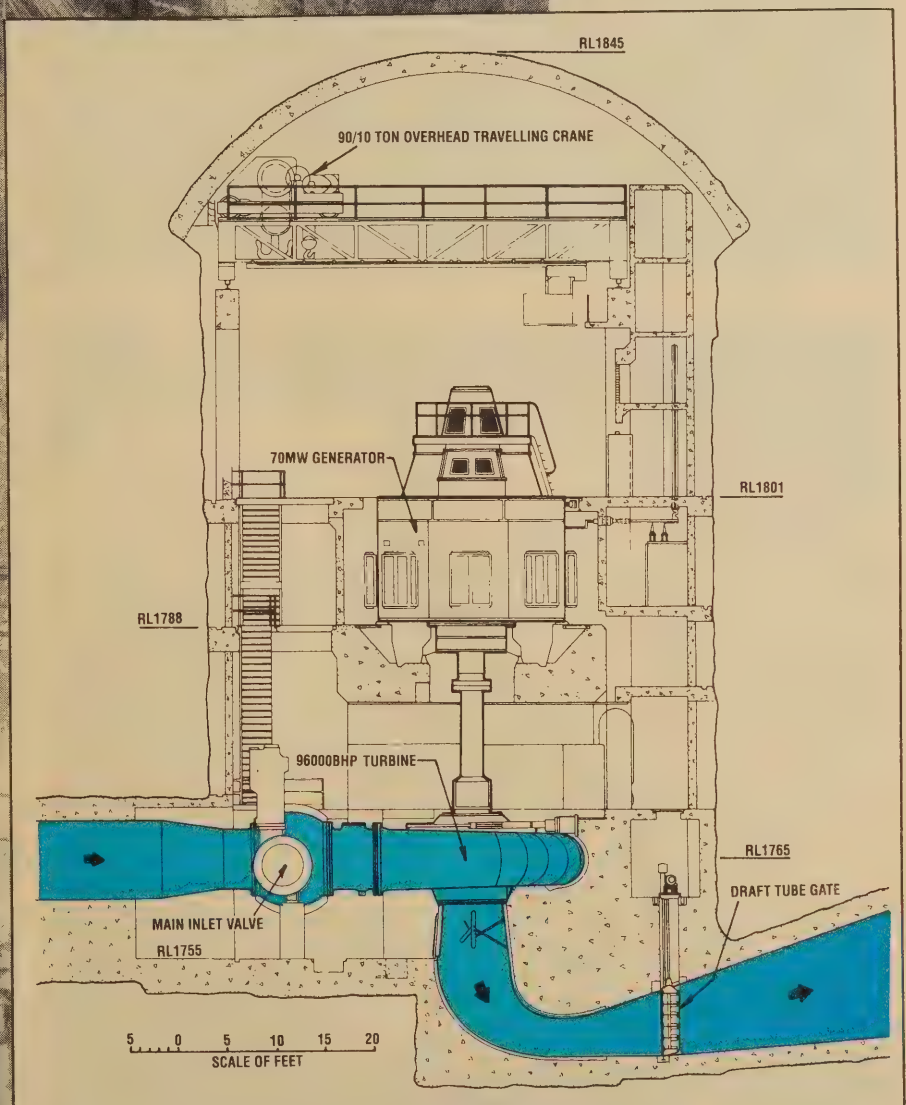


Fig.4: cross section of the Tumut 2 power station which, like Tumut 1 station, is built entirely underground in a chamber excavated out of the rock.

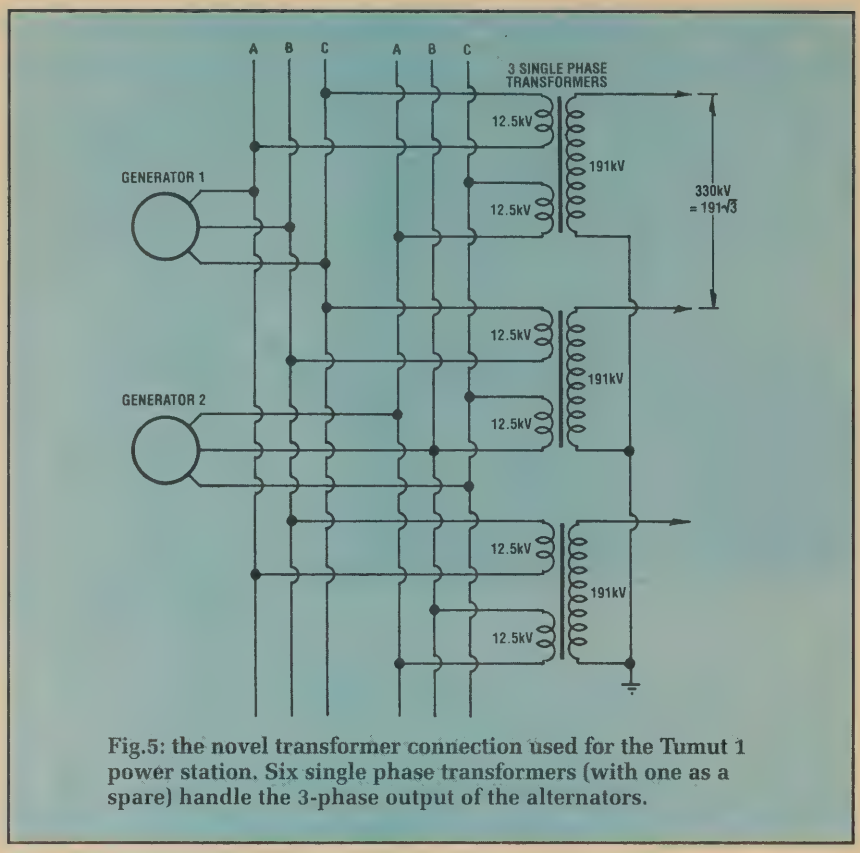


Fig.5: the novel transformer connection used for the Tumut 1 power station. Six single phase transformers (with one as a spare) handle the 3-phase output of the alternators.

Tumut 1 power station as it is today - quiet, reliable and pollution free.

or shutting down of any of the Tumut 2 machines. At the same time, Tumut 1 must be allowed to run at full power.

For this contingency, a huge surge tank and overflow spillway was constructed at the junction of Tumut 2 pressure tunnel with the two downcomers (ie, exit pipes).

The vertical surge tank, 8.5 metres in diameter and 76 metres high, was excavated within the mountain, steel reinforced and concrete lined. The top of this tank opens to a huge spillway capable of discharging 7474 cubic metres of water per minute.

Exit Tumut 2

Having passed through the Tumut 2 turbines, water exits via the 6km long tailwater tunnel to be returned to the Tumut River downstream. From this point on, the water flows aboveground, eventually to pass through yet more power stations.

The rest of this story, including pump storage (effectively storage of AC electricity), the Murray system and the first interconnection of three states' electricity grids, will be left until next month.

Power & energy

Some readers may be puzzling over a small apparent discrepancy: Tumut 1 power station, with four machines, generates 320MW; using the same number of turbines and literally the same water, Tumut 2 only provides 280MW. Why the difference?

The reason is to do with the head of the water. Tumut 1 turbines are driven by water at constant pressure caused by its 292 metre head. On the other hand, Tumut 2 works from a 262.1 metre head. Less pressure at Tumut 2 means that the turbines cannot produce as much power, even though the water flow rates of both power stations are equal.

Interestingly, whereas Tumut 1 machines rotate at 375 RPM, the smaller machines at Tumut 2 run faster at 428.57143 RPM (long term average). Why? The alternators at Tumut 1 have 16 poles while those at Tumut 2 have 14 poles.

Acknowledgement

Special thanks and acknowledgements to Libby Langford and the Snowy Mountains Hydroelectric Authority for data, photos and permission to publish. SC

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VINTAGE RADIO

By JOHN HILL

Getting out of trouble again

Some time back I wrote an article about getting out of trouble. No it wasn't about some domestic problem or a brush with the law; it was about getting out of the sort of trouble that vintage radio restorers frequently run into. Repairing old radios is not always easy!

The previous story was well received so I have decided to do another one along similar lines, but solving different problems. The first example is a good illustration of the troubles one can encounter when tinkering around with ancient radios.

The receiver in this case was not mine. It belonged to a guy I know who runs an antique shop. He usually doesn't stock old radios in his shop because he claims that they are too troublesome, but he bought this particular set because he liked the look of it. In fact, he liked it so much that it went into his house and not the shop.

Both he and his wife enjoyed their old radio for a while, until it started to crackle and make strange noises. In due course, it ended up on my workbench for repair. The radio was a 5-valve German Saba, a large table model with a tuning indicator and a timber cabinet.

As is typical of some European sets, it required more than the usual time and effort before the chassis and loudspeaker were on the benchtop, ready to be worked on. And it was obvious from the start that the radio had been serviced on several previous occasions. The strange mixture of valves alone was enough to attract anyone's attention. There were two original metal valves, one miniature 7-pin valve and one octal valve.

In addition, the rectifier valve was missing and had been replaced by solid state diodes.

The loudspeaker and several other components were dated February, 1939. No doubt this particular radio had relayed the rantings and ravings of the Fuhrer himself to some German family during the war years.

German metal valves were nothing like their American counterparts. Finding replacements for these valves was a problem for servicemen over many years & led to many substitutions.

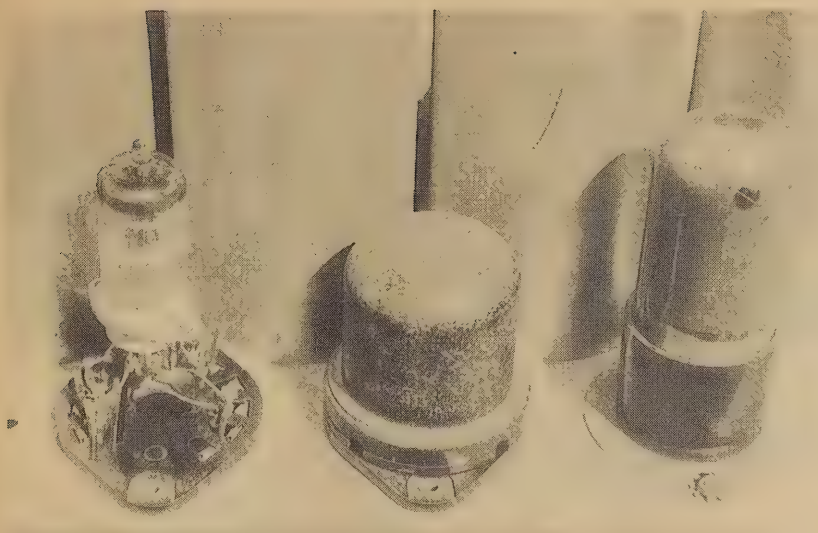
German metal valves

The two original metal-cased valves in the receiver were an ECH11 and an EBF11. I twigged to the valve problem straight away because I had read about German metal valves only a few days before.

These valves were Germany's answer to the American octal metal valves. However, the valves were by no means interchangeable because the German 8-pin base configuration was nothing like the American octal configuration (see photograph).

The valve construction was different too. Instead of the valve elements being arranged vertically as was the established pattern of the times, the German metal valves were made with the electrodes running horizontally. While this made no difference to the operation of the valves, it made a big difference to their size and they were much larger in diameter than the American metal types.

Apparently, the German valves did not become popular (although Philips produced some) and the intervention of the war only made this situation worse. German metal valves, it seems,



Only one of the these three valves in the old Saba is an original. At left is the substitute 7-pin IF amplifier, at centre the original EBF11 duo diode triode (AGC, detection & first audio), and at right the substitute 6V6 audio output valve.

The rectifier valve had been replaced with high voltage solid state power diodes. This is not the sort of thing a vintage radio restorer would do unless he had no alternative.

were used mainly by the Germans.

As a result, the receiver on my workbench was a hard one to buy valves for. Now I'm not saying that they are unobtainable, but the chances of obtaining a set of these oddball valves would be pretty slim. They would be quite costly too!

Interesting solutions

The interesting aspect of this set is the ways in which presumably different servicemen have overcome this valve replacement problem.

As previously stated, the rectifier replacement was easily solved by substituting solid state diodes. Some power diodes are rated at 400 or 1000 volts and these are suitable substitutes for a thermionic rectifier valve.

However, this modification will increase the high tension (HT) voltage significantly above that available from a normal rectifier valve setup. For this reason, the HT voltage should be checked and resistance added to the supply line, ideally between the rectifier and the first electrolytic, to restore a reasonable value. The actual value is best determined experimentally and a resistor rating of 5 watts will usually be necessary.

(Editorial note: the cathode/plate impedance of a vacuum rectifier, such as an 80 or 5Y3, is relatively high. At typical current drains (80-100mA), the DC voltage from the rectifier is approximately equal to the RMS supply voltage.

On the other hand, the loss across a silicon diode is of the order of only a volt or less, regardless of current drain. As a result, the voltage across the first filter capacitor can approach the peak value supply voltage or 1.4 times the RMS voltage).

The ECH11 frequency converter valve was still working OK, so this part of the receiver had not been altered. However, the intermediate frequency (IF) amplifying valve had most definitely been tampered with. As shown in the accompanying photograph, the original valve has been replaced with a 7-pin miniature type. This valve is mounted above the old socket, with leads running down through the old socket to the circuit underneath the chassis.

This conversion may look a bit makeshift but it is effective and the substitute valve can be replaced as easily as the original.

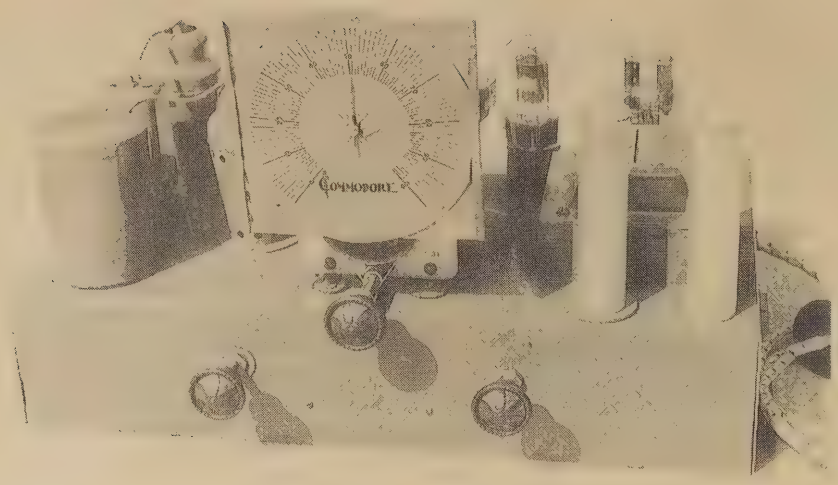
The next valve was the EBF11, a duo diode triode which handles the automatic gain control, detection and first audio functions. These operations were still being looked after by the original valve and again there were no modifications to this part of the circuit.

6V6 transplant

The final stage, the audio output, was another substitution job and it was done in a different manner to the IF valve and the power rectifier. In this case, the original valve socket had been replaced with a standard octal socket and a common and easily obtainable 6V6 valve installed in its place.

This 6V6 transplant is perhaps the neatest way to go about this type of modification. While the little IF valve mounted up on stilts works OK, it is not as neat a job as the output valve set up.

Likewise with the diodes soldered to the empty rectifier socket. Admittedly it is a satisfactory repair, but not the type of thing a vintage radio man would go for. An empty valve socket



This particular receiver can be converted from 2.5V to 6.3V valve operation simply by plugging in the new valves & adding a 6.3V heater transformer. Not all sets can be converted this easily, however. It all depends on the original valve complement.

looks as though something is missing. If a repair of this nature has to be done, then at least leave the old valve in its socket and install the diodes underneath the chassis where they are out of sight.

Naturally, the serviceman and the vintage radio restorer see things differently. The serviceman is only concerned with getting the receiver working again. The vintage radio enthusiast, on the other hand, not only wants it working but also wants the set to continue looking as it did before.

In the case of the old Saba with its oddball metal valves, originality cannot be easily achieved. Perhaps a conversion to octal valves would not be a bad modification in this instance. In fact, a set of octal metal valves would surely be a reasonable compromise.

But while it's easy to suggest altering the set to suit readily available valves, converting the receiver is a big job. Not only would the changeover be time consuming but it must also be done with considerable care.

First, the substitute valves will need to be fairly close equivalents to the originals. Second, each new socket must be fitted and rewired in accordance with the original socket connections. Any foul-ups here could be very difficult to locate later on.

So a job of this nature requires a systematic routine. As each socket connection is disconnected, the lead or leads should be taped together and labelled. Perhaps the serviceman's not so neat techniques are not so bad after all.

Curing the problem

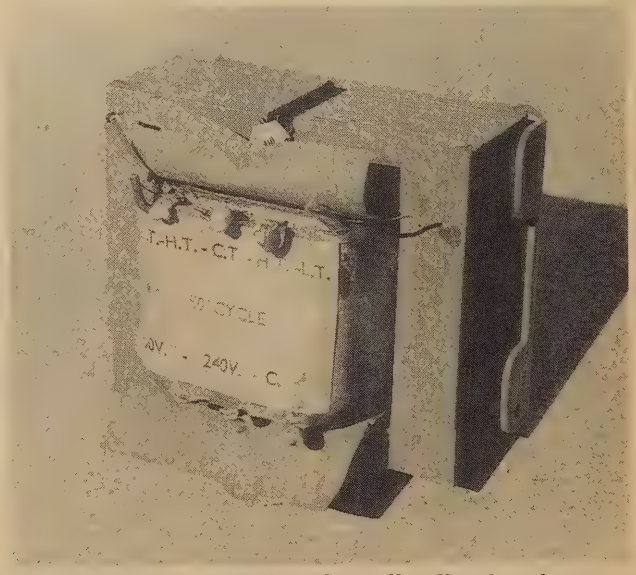
To finish off the story on the Saba, replacing a suspect electrolytic and a couple of sick looking paper capacitors solved the crackling problem. The set was then returned to its owner with the advice to sell it either to his worst enemy or to someone with the time and resources to restore it to original condition.

It's not that bad really, but the old Saba could be an awkward one to repair the next time something else goes wrong.

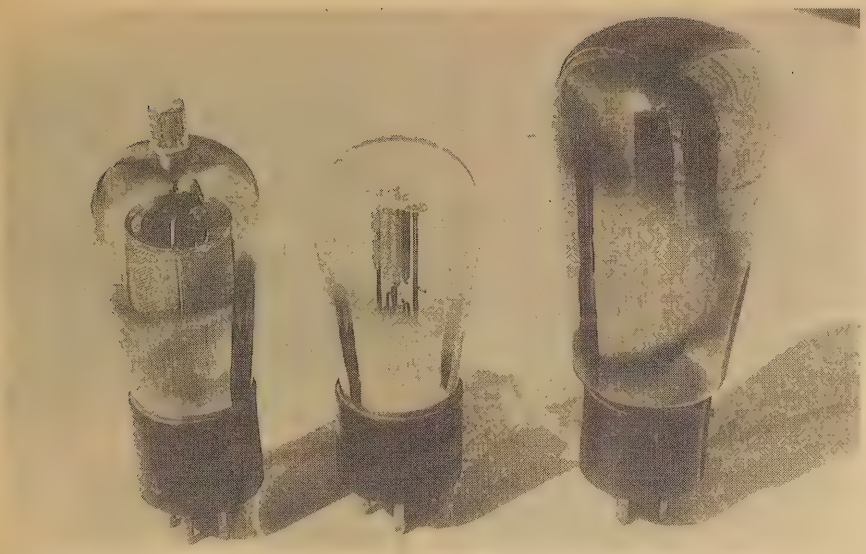
Continuing along in the same vein, any type of valve modification is OK if it allows a receiver to be repaired satisfactorily. If an obscure type of valve can be easily replaced with a more common type, it can save a lot of trouble and expense.

A receiver with hard-to-get 2.5 volt

Many valuable old valves can be reclaimed by replacing missing top caps. This involves resoldering the top cap to the lead where it emerges from the glass & then securing the cap to the glass with a couple of drops of Superglue®.



A small transformer such as this will suffice for a heater transformer. In some sets, converting from 2.5 volt valves to 6.3 volt equivalents is one way of solving difficult valve problems.



Old 2.5V & 4V series valves such as these are often difficult to obtain and substituting other valve types is one way of getting a set going again.

valves can be converted to early 6.3-volt valves without too many hassles due to the fact that the valve bases are the same. In favourable circumstances, all that is required is a 6.3 volt transformer for the valve heaters in place of the original 2.5 volt supply.

There is often plenty of room under the chassis to mount another transformer and special "heaters only" transformers for that specific purpose were made in the past.

In many cases, no other rewiring may be required. Many of the early 6.3 volt valves were direct equivalents to their 2.5 volt brethren, the heater voltage being the only difference.

In other cases, careful consideration must be given to the existing valve types and to those that will replace them. The job may not be as easy as first thought. For example, a 2.5 volt 59 output valve with its 7-pin base has no convenient 6.3 volt equivalent. On the other hand, a 2A5 can be replaced with a 42, the heater voltages being the only difference with these valves.

Missing top caps

There is just enough space left for one more valve hint and it concerns valves with missing top caps. Usually another top cap can be soldered back on and a couple of drops of superglue will hold it firmly in place. But sometimes the grid wire breaks flush with the glass and there is nothing to solder to.

When this is the case, the glass can be nibbled away with a knife or some other suitable tool until it exposes a short length of the wire. With care, an extension can be soldered onto the stump and, in turn, soldered to the top cap. This process may be a bit fiddly but it effectively restores an otherwise useless valve to working order again. SC

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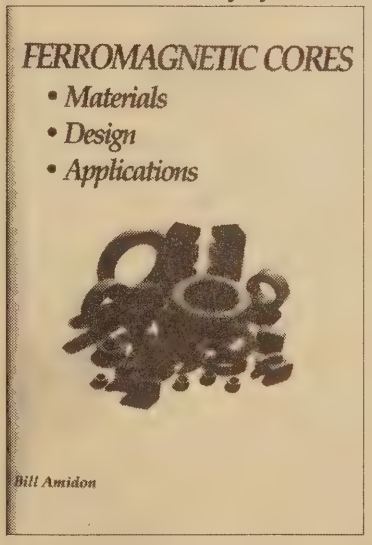

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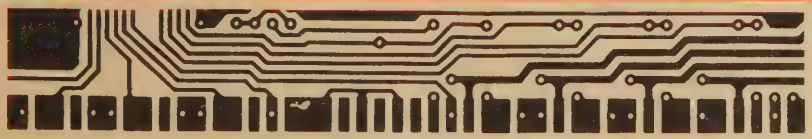

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AMATEUR RADIO

BY GARRY CRATT, VK2YBX

Ferrites - how they work & why they are used

In many RF applications where large values of inductance are required in physically small areas, air spaced inductors cannot be used because of their size. The solution is to use ferrite-cored inductors.

One way of decreasing the size of a coil while maintaining a given inductance is to decrease the number of turns but increase the magnetic flux density. This flux density can be increased by decreasing the reluctance, or magnetic resistance path, between the windings of the inductor.

It's possible to do this by adding a magnetic core material, such as iron or ferrite, to the inductor. The permeability (μ) of either of these materials is much greater than of air and thus the magnetic field is not as "reluctant" to flow between the windings when compared to an air-spaced inductor.

The net result of adding some kind of magnetic core to an inductor is the ability to produce a given inductance with less turns. There are several advantages in doing this: (1) smaller size; (2) increased Q (less turns means less DC resistance); (3) variability - this can be obtained by physically moving the core through the windings. However, such an approach requires careful selection of the core for a particular application.

For example, if the core permeability is excessively high for the frequency at which the inductor is used, the circuit will be more sensitive to temperature variations (ie, temperature variations will cause excessive variations in the value of the inductance). Also, if the permeability is too high for the frequency of operation, saturation of a magnetic core may result, which again changes the value of the inductor.

All magnetic core materials tend to introduce loss. The correct material must be chosen for the appropriate frequency. If incorrect material is used, it may make no difference to the realised inductance as the core may appear "transparent" if its permeability approaches that of air. In addition, if the permeability is too high, core saturation may result.

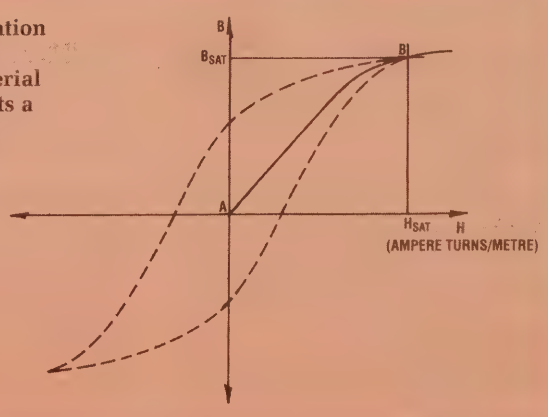


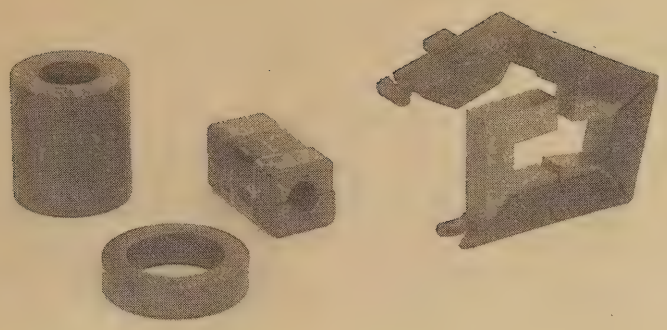
Fig.1: typical magnetisation curve for a ferrite core. Note that once the material is magnetised, it exhibits a degree of hysteresis, as indicated by the dotted curves.

Magnetisation curve

Fig.1 shows the typical magnetisation curve for a magnetic core. The curve simply indicates the magnetic flux density (B) that occurs in the inductor with a specific magnetic field intensity (H) applied. As the magnetic field intensity is increased from zero (while increasing the applied signal voltage), the magnetic flux density between the turns of the inductor increases linearly. The ratio of the magnetic flux density to the magnetic field intensity is called the permeability of the material.

At this stage, we could branch into a mathematical discussion relating to the calculation of permeability. However, all we need say is that the permeability of material is a measure of how well it transforms an electrical excitation into a magnetic flux. The better it is at this transformation, the higher the permeability.

For our application, we need to keep the excitation level low enough to maintain operation in a linear portion of the curve. Any further increase in excitation may cause core saturation,



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at which point no further increase in magnetic flux density can occur.

Saturation

The magnetic flux density at which saturation occurs (B_{SAT}) is specified by manufacturers and varies substantially from core to core, depending on the size and shape of the material.

It's important to know the B_{SAT} for a particular core as this will determine the suitability for a particular circuit. As the B_{SAT} is a published figure, we need to know the in-circuit operational flux density (B_{OP}). This can be mathematically determined by the formula shown below.

$B_{OP} = E \times 10^8 / 4.44(fNA_e)$, where

B_{OP} = magnetic flux density in Gauss

E = maximum RMS volts across the inductor

f = frequency in Hz

N = number of turns

A_e = cross sectional area of the core in cm^2.

If the calculated B_{OP} for a particular application is less than the published specification to be set for a particular core, then the operation will be largely linear and the core will be suitable for the application.

There are really no fixed rules governing the use of ferrite cores versus powdered iron cores in RF circuits. In many instances, given the same permeability and type, either type could be used without any change in performance. But there are some exceptions to this rule. Powdered iron cores can typically handle higher RF power without saturation core damage than the same size ferrite cores.

For example, ferrite tends to retain its magnetism permanently if driven with a large amount of RF power. This means a permanent change to the characteristics of the permeability. By contrast, powdered iron will eventually return to its initial permeability if overdriven.

So in any application where high RF power levels are involved, iron cores might seem to be the best choice. Also, in general, powdered iron cores tend to yield higher Q inductors at higher frequencies than the same size ferrite core. This is due to the inherent core characteristics of powdered iron, which produces much less internal loss than ferrite.

This characteristic of powdered iron makes it very useful in narrow band or tuned circuit applications, as commonly encountered in receivers and transceivers.

Table 1 shows various types of powdered iron material and their frequency classification. However, ferrite cores have a significant advantage and that is that their permeability is much higher than for the same size powdered iron core. This means that a coil of given inductance can usually be wound on a much smaller ferrite core and with fewer turns. And this in turn means that less circuit board area is used.

General composition

Most readers can imagine the composition of a powdered iron core but few may be aware of the nature and composition of ferrite. The general composition of ferrites used for magnetic cores is a ceramic iron oxide with the general formula $MeFe_2O_4$, where Me represents one or several of the divalent transition metals such as manganese, zinc, nickel, cobalt, copper, iron or magnesium.

The most popular combinations are manganese and zinc or nickel and zinc. These compounds exhibit good magnetic properties below a defined temperature called the Curie Temperature (CT). These materials can easily be magnetised and have a very high intrinsic resistivity. Such material can

Table 1: Powdered Iron Materials

Material	Properties	Applications
Carbonyl C	Medium Q at 150kHz; high cost	AM tuners; low frequency IF transformers
Carbonyl E	High Q & medium permeability from 1-30MHz; medium cost	IF transformers, antenna coils, general purpose designs
Carbonyl J	High Q at 40-100MHz; medium permeability; high cost	FM & TV circuits
Carbonyl SF	High Q to 50MHz	Similar to Carbonyl E
Carbonyl TH	Higher Q than carbonyl E up to 30MHz, but less than carbonyl SF	Similar to carbonyl E
Carbonyl W	High Q to 100MHz; medium permeability; high cost	FM & TV circuits
Carbonyl HP	Excellent stability & good Q	Low frequency applications to 50kHz
Carbonyl GS6	Good stability & high Q	Commercial broadcast frequencies
IRN-8	Good Q from 50-150MHz; medium priced.	FM & TV circuits

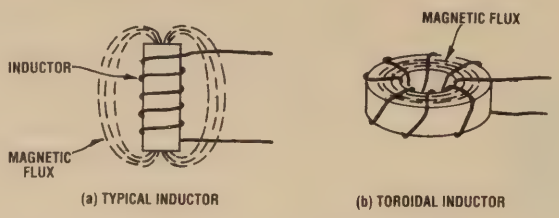


Fig.2: toroidal inductors radiate far less than conventional inductors since the magnetic flux is contained within the material itself.

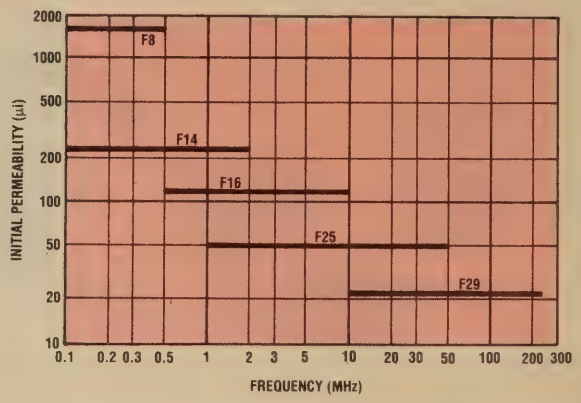


Fig.3 (right): this graph shows the optimum frequency ranges for various grades of ferrite.

be used to very high frequencies without laminating, as would normally be required when using other magnetic metals.

Manufacturing process

The manufacturing process for ferrite is quite remarkable. The raw materials used are oxide or carbonates of the constituent metals. The final material grade determines the necessary purity of the raw materials to be used. The base materials are weighed in the correct proportions required for final composition and the powders then mixed to obtain a uniform distribution. Finally, the mixed oxides are calcined at approximately 1000°C.

This process is called "sintering" and consists of mixing metal powders having different melting points, and then heating the mixture to a temperature equal to the lowest melting point of any of these metals. A solid state reaction then takes place between the constituents and a ferrite is formed. Pre-sintering is not essential but provides a number of advantages during the remainder of the production process.

Pre-sintered material is milled to a specific particle size, usually in a slurry with water. A small proportion of organic binder is added and then the slurry is spray dried to form granules suitable for forming.

Most ferrite parts are formed by pressing. The granules are poured into a suitable die and then compressed. The organic binder acts in a similar way to an adhesive and a so-called "green" product is formed. This is still very fragile and requires sintering to obtain the real ferrite properties.

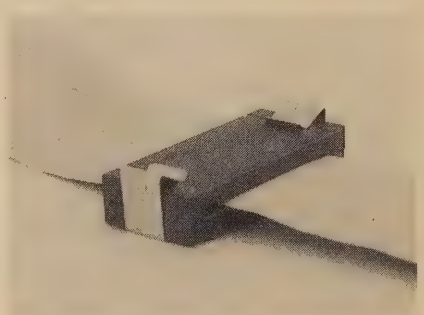
For some products (eg, long rods or tubes), a material is mixed into a dough and extruded through a suitable die. The green cores are loaded on refractory plates and sintered at a temperature between 1150° -1300°C, depending on the ferrite grade. A linear shrinkage of up to 20% takes place (note: the material can be cut to length either before or after sintering).

Sintering may take place in tunnel kilns having a fixed temperature and atmosphere distribution, or in box kilns where temperature and atmosphere are computer-controlled as a function of time. The latter type is more suitable for high grade ferrites. After sintering, the ferrite core has the required magnetic properties and dimensions typically within 2% of nominal size (because of variations in shrinkage).

Toroids

The self-shielding properties of a toroid become evident when Fig.2 is examined. In a typical air-cored inductor, magnetic flux lines linking the turns of the inductor take the shape shown in Fig.2a. This clearly shows that the air surrounding the inductor is definitely part of the magnetic flux path. Thus, the inductor tends to radiate the RF signals flowing through it.

A toroid on the other hand (see Fig.2b) completely contains the magnetic flux within the material itself, and thus no radiation occurs. This characteristic of toroids eliminates the need for bulky shields around an inductor. These shields not only reduce available space but they also reduce the Q of the inductor that they are shielding.



Large split ferrite shields can be used to suppress noise in computer ribbon cable. The unit shown here is available from Stewart Electronic Components Pty Ltd.

Ferrite beads

Most readers will also be aware of suppression beads which are manufactured from relatively high permeability ferrites and then threaded onto wire leads. At frequencies well beyond the normal operating range, these beads provide a series impedance, the resistive component of which acts as an imaginary resistor in series with the circuit being protected, while the reactive component looks like a series inductance.

Suppression beads are used in this manner to prevent high frequency leakage and to prevent parasitic oscillation arising from spurious feedback. They are also used for the suppression of interference. This form of protection is possible because at frequencies far removed from the normal range of application, the losses in ferrites are very high.

A ferrite bead threaded onto a lead produces no noticeable direct affect on the operation of equipment because at low frequencies, the series

impedance is very low. But while the bead has no effect at low frequencies, it acts as a suppressor at very high frequencies. This is because the losses in the ferrite become high at high frequencies. At the same time, the reactance generally increases with frequency in spite of a gradual loss of permeability.

This decrease in permeability becomes noticeable at frequencies 10-20 times higher than the upper limit of the normal range of application.

Fig.3 shows the optimum frequency ranges for various grades of ferrite. When using ferrite as a suppression bead, it is important to use a grade where the impedance is high at the frequency we wish to suppress. The series impedance of a wire threaded through a bead is proportional to the length of the bead or the number of beads used.

Alternatively, several turns of wire can be wound through the bead to produce a higher impedance. This technique is often used at VHF. Many popular electronics outlets also stock a 6-hole suppression bead which provides even more protection. So it can be seen that ferrites can be used to eliminate all sorts of interfering signals due to the high losses in ferrite material at high frequencies.

It has also been demonstrated that ferrites can play a valuable part in the design of modern communications equipment, as they allow a reduction in circuit board area due to the shielding effect. Some communications equipment specialists even stock a range of feed-through capacitors with built-in ferrite beads. This combination forms a π-section filter and is very effective where space is limited.

These feedthrough capacitors come with built-in ferrite beads & make very effective π-section filters where space is limited.

In addition, "split ferrite shields" are now available for use on computer ribbon cable (see photo).

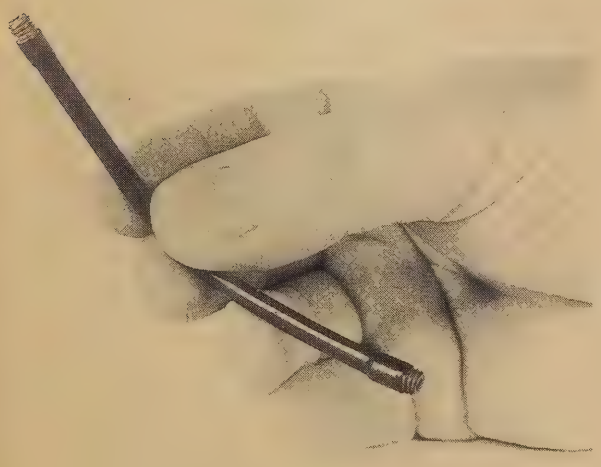
Another simple yet practical use for ferrite is the "magic wand". This uses a ferrite slug attached to one end of a piece of PVC tubing and a brass grub screw at the other end. To determine if a coil in a circuit requires more or less inductance for optimum operation, either slug is inserted into the coil. The ferrite slug will cause an increase in inductance while the brass slug causes a decrease.

So the magic wand can be used as a tuning aid, when adjusting tuned circuits.

Further reading

(1) Neosid Magnetic Components Catalog.
(2) "Ferromagnetic Cores", Stewart Electronics Components Pty Ltd..
(3) "Ferrites"; Siemens Databook.
(4) "Magnetic Products Data Handbook - Soft Ferrites"; Philips Components.
(5) "RF Circuit Design"; Sams Books.
(6) "Ferrite Cores-2 For Telecommunications & Industry Fields"; TDK Databook.

SC



A simple tuning wand can be made by attaching a ferrite slug to one end of a piece of PVC tubing and a brass grub screw to the other.

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Help needed to obtain parts

I am in need of some special parts and would like to know where I can get them from. I think they are MOSFETS, FETS or power transistors and the case is, I think, either 90-05 or 199-04 or similar.

The only clues as to what they are or do are their part numbers. They are both Toshiba parts - the part numbers being 2SC32 and 2SA02 - and are made in Japan. If you or anyone else can help I would greatly appreciate it. (J. Evans, Blackburn Sth, Vic).

Endorsement of the high energy ignition system

Two or three weeks back, I phoned to say that my high energy ignition (HEI) kit did not perform as well as my older dwell extended TAI. The TAI gave my 202 HZ Holden Kingswood tremendous power and fuel economy, particularly at low RPM. The HEI now has identical performance to the TAI.

I should point out that this 3.3-litre six spends most of its time running below 2500 RPM and might occasionally hit 4000 RPM on the highway. So the low power range from 600-3000 RPM is of particular interest to me.

I made the following changes individually with subjective testing after each change, over several days.

My low power test is a hill outside my home. If I had to move the throttle more than the tiniest amount, the change was ineffective. My high power test is a half-kilometre hill in an 80km/h zone near my home. The speed limit should be obtainable and maintainable with less than full throttle.

The changes I made are in chronological order with the results alongside.

(1). Fitted and checked HEI; results were disappointing across the entire range: (a) low power test - over half throttle required; (b) high power test - full throttle maintains 80km/h.

(2). Boosted lead sizes from 8-amp figure 8 cable to 20-amp 240V V105 cable: (a) low power test - about half throttle; (b) high power test - full throttle yields about 85km/h.

(3). Installed a 0.22µF collector capacitor on the Darlington transistor: (a) low power test - about 1/3 throttle; (b) high power test - full throttle yields about 85km/h.

(4). Mounted the unit in the same position as on VH 202 Commodore ie, 2.5cm from distributor. Shortened the primary path by connecting the coil primary direct to the Darlington transistor instead of via the PC board. The total primary lead length is now 22cm: (a) low power test - about 1/4 throttle; (b) high power test - full throttle would exceed 90km/h, speed limit now maintainable, with less than full throttle

(5). Increased the collector capacitor to 0.47µF 630V polyester: (a) low power test - less than 1/4 throttle; (b) high power test - full throttle would exceed 100km/h, significantly less than full throttle required to maintain speed limit.

Increasing the capacitor above 0.47µF yielded less than favourable results, so I went back to the 0.47µF.

(6). Replaced both five watt wire wound resistors with carbon film 1W units in parallel to achieve the same result. This has improved the high power test slightly.

I liked the HEI when I first saw the circuit because it uses high voltage/high temperature components. The TAI ran hot which worried me. The 0.487V collector voltage of the MkII and the 0.946V collector voltage of the HEI makes no measurable difference in performance. The fuel economy and performance of the vehicle is now excellent.

A few additional comments: (1). Dwell extension dates back to 2-point distributors in the early 1930s; (2). CDI crossfire is something I have never experienced, even though I fitted CDI systems to four Holdens.

What appears to be detonation/pre-ignition caused by crossfire is actually a byproduct of the improved efficiency of the engine. All my electronic ignitions, whether they were CDI, TAI or HEI, revealed pre-ignition/detonation on long grades.

The explanation as to why this happens goes like this: (a) a lean mixture burns slow and hot; and (b) a rich mixture burns fast and cold.

The electronic ignitions improve the

Problem with the Steamsound Simulator

I have built three Steamsound Simulator kits, two for my friends and one for myself. Wouldn't you know it, the unit I built for myself would not operate properly. The kit operates but the volume is well down. I've tried replacing the LM324 op amp IC but no luck. I'd certainly appreciate a little advice. (W. C., Cooroy, Qld).

• Generally, circuits such as these do not have faulty ICs.

You should be able to check the operation of the circuit by dividing it into two parts. For example, you can check the main op amp and the noise generator circuitry by connecting a 6V DC supply across the 0.1µF capacitor at the junction of the 150kΩ/330kΩ resistors. This should give you quite a high noise output from the speaker.

If this does not occur, the most likely suspects are Q1 (the noise transistor) the speaker itself or its associated 10µF coupling capacitor. If the foregoing check proves to be OK, then the problem is likely to be in the modulation part of the circuit and possibly involves Q2.

combustion efficiency of the engine permitting the (a) scenario at speed ranges the manufacturer never envisaged because his standard ignition produced scenario (b). The solution is to fit spark plugs of the same gap, thread etc, but with "colder" heat range. Note: full throttle killed the detonation. Had the symptom been crossfire; it would have become worse under full throttle. (T. G., Waverton, NSW).

• While we agree that low impedance connections to the high energy ignition system are very important, particularly the chassis return path, the addition of a collector capacitor to the Darlington transistor should have no effect. In fact, we are inclined to the view that it may make the circuit less effective.

The reason why is that the collector capacitor can only slow down the rise time of the voltage in the primary when the transistor switches off. The capacitor would certainly affect the amplitude and frequency of the coil's primary resonance but if the circuit is working correctly - ie, with dwell extension - no primary ringing should occur.

We are also doubtful about the accuracy of your subjective tests. It would be quite easy to be mistaken with anything less than a full power test. Part throttle testing is fraught with difficulty. In other words, if it is not done on a dynamometer it is impossible to be objective.

Your comments about capacitor discharge ignition are interesting but we feel that it is significant that no car manufacturer has elected to install CDI as original equipment. Cross-fire certainly does occur and it can cause considerable damage to piston crowns.

Questions on the 6-metre amplifier

I am building your design for the 5-watt power amp for the 6-metre band. However, I only want 1 watt out of it because I already have a converted AWA 2-way radio power amp which needs 1 watt input. Also, I have a commercial brand power amp which is made for the 6-metre band but has a maximum input of 3 watts.

I think I only need to build your PA up to the 2nd transistor then connect it to one of my more powerful PAs. How can I best do this?

Also, instead of your exciter, I wish to use a Tandy walkie-talkie which transmits FM just off the amateur band. All I would have to do is change the crystal in it to an amateur 6-metre frequency. What is the best way to connect the Tandy radio to your PA? Would any changes have to be made to the input components?

On a related subject, 2-metre radios are expensive to buy and so are the bits. However, I have a 1-watt transmitter made from a Dick Smith Electronics kit but it has only one channel. It produces a 24MHz signal on one circuit board and this is the fed to a second board which triples and then doubles the frequency and outputs a 1-watt signal.

Could you work out something that could produce all 144-148MHz frequencies, perhaps using parts from one of the Dick Smith Electronics 2-metre kits? This could then be fed into some type of amplifier such as in the 1-watt 2-metre FM transmitter kit. If you could find a frequency synthesiser that could be used, this may be a lot cheaper than buying a full 2-metre transceiver.

Also, I have two other 2-metre transmitters but they also need crystals for each channel. One has a crystal frequency of about 8MHz and the other is 36MHz. Could a frequency synthesiser be found to fit these? (V. S., Copacabana, NSW).

• We think it should be possible to build the 6-metre power amplifier up the second stage and couple the output signal to the output via the same tank circuit as the deleted output stage.

Your other questions are really beyond the scope of what we can answer in these pages. You should be able to get more help by contacting your local amateur radio club; ie, the Central Coast Amateur Radio Club at Gosford.

Electronic solution to long showers

After years of banging on the bathroom door and/or turning the hot water system off to get my teenage children out of the shower, I realise there must be an electronic solution.

I envisage an electronic timer, similar to the Iron Timer (SILICON CHIP, August 1990) which connects between the power supply and the hot water system and permits it to be on for no more than 10 minutes, after which is resets automatically in two minutes (which is too long for even the cleverest child to withstand the cold shower water before it resets).

Kids only need to be in the shower for no more than 10 minutes. Also, this is adequate time for a washing machine to fill with warm water.

The hot water system that we have is very common and is probably the best for this idea. It is a 3-phase instant starter with no reservoir which, according to the SEC energy book, is the most efficient. Even so, cutting my two teenagers' showers from 20 to 10 minutes a day (each) would save between $30 and $40 a quarter, which is probably enough to pay for this project.

The shower timer could be wired into, or replace, the centre fuse of a 3-phase hot water system and could stay in the meter box on a permanent basis. (S. P., Melville, WA).

• We are not in favour of a timer circuit which would connect into your 3-phase circuitry. It is far too dangerous and could infringe wiring regulations.

However, it may be possible to provide an alternative circuit which operates a water solenoid, as used in washing machines and dish-washers. We'll consider the idea for a future project.

Questions on hifi equipment

I was wondering why you have used so many bipolar capacitors in the Studio 200 Control Unit. I would have thought they wouldn't have been a good type to use in a hifi preamp. I know they're frowned upon when used in speaker crossovers.

I realise that their poly equivalents would be large, expensive and even unavailable in some values. I guess that in other circuits normal electros

Class A amplifier system wanted

Congratulations on your magazine. Being involved in mechanical engineering, your electronics magazine stimulates me - it's great.

One of the areas that interests me is stereo amplifiers and loudspeaker systems. Let me try to explain. Amplifiers are often overpowered and this power is never directed correctly to achieve the performance acoustically. Too often are kits bought, only to have add-ons attached to perform required functions. These are shoddy and are susceptible to hum.

What's needed is for you to design a complete system, to be heard, looked at and admired for years to come and to be envied by all those that deserve it.

The system must be class "A". Suitable specifications perhaps would be 50W RMS per channel L&R front, 50W RMS per channel L&R rear, 100W RMS subwoofer with variable volume control and frequency control (variable from 30-140Hz with digital readout), and separate volume-balance and tone controls per front and rear speakers.

It should also be a complete unit with preamps, five power amplifiers and a time delay control for the rear speakers.

Two and a half thousand dollars for the loudspeakers and amplifiers is acceptable. Don't penny pinch. A project like this could run for many months and would be built by thousands and admired and talked about for years to come. It would be the reference. (R. L., Somerville, Vic).

• Your proposed class A system would be very large, very heavy and very expensive and we wonder just how many people would be interested in this level of commitment. What do other readers think of the idea?

would be used; are these not suitable?

Also, what is an M/N pot as used for the balance control? And why wasn't a switch-on muting circuit included in the Studio 200 preamp control unit.

I was pleased to see the AM Stereo Tuner Mk II come to fruition. I was about to write regards when/if you would follow the portable one and you saved me the trouble by publishing it. I will be building it as soon as I get a spare $199 for the kit.

It's a shame you didn't include narrow/wide and stereo/mono switches to add a bit of control but nevertheless it's a nice looking unit and I'm dying to get my hands on a kit. A specification panel would have been nice to accompany the article.

What do you mean by ±12kHz @ -3dB? I can understand +3dB or -3dB at 12kHz but not the above. I assume the tuner has an audio response of 12kHz or it wouldn't sound "nearly as good as FM" as you state.

Thanks also for the audio expander. Is there any reason a transformer couldn't be enclosed inside the case instead of an external power pack? (P. G., Orient Point, NSW).

• Bipolar capacitors are satisfactory in a hifi circuit as long as they do not have any appreciable signal voltage across them.

An M/N pot is a special log/antilog pot in which each element has half of its travel shorted out. This is to stop the gain of one channel increasing as the other channel is turned off.

A switch-on muting circuit was not included because the Studio 200 does not produce switch-on thumps and nor does it produce any switch-off thumps. By the way, most commercial stereo control units do not have switch-on muting included.

The specification ±12kHz @ -3dB refers to the IF bandwidth; ie, the response is down 3dB at +12kHz and -12kHz from the centre frequency of 450kHz. The final audio response of the tuner is about 8kHz.

Finally, a power transformer can be added to the audio expander although you will need to use a larger case. **SC**

SEND IN YOUR APPLICATION

For your share of the prizes

In the March and April issues of ***Silicon Chip*** we published the **Remote Controller for Garage Doors.** The feedback from this project has been enormous.

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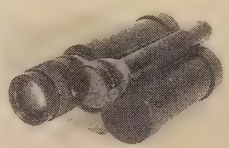

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Zero Mode[2]		●	●	●	●	●
Live Trend Memory[3]		●	●	●	●	●
Logic Function		●	●	●	●	●
Min/Max Recording			●	●	●	●
Store 5 readings			●	●	●	●
Relative Mode			●	●	●	●
RMS Conversion					●	●
Frequency					●	●
dB level					●	●
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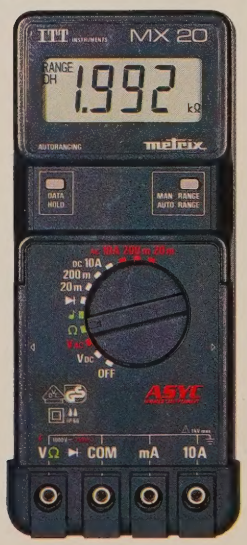

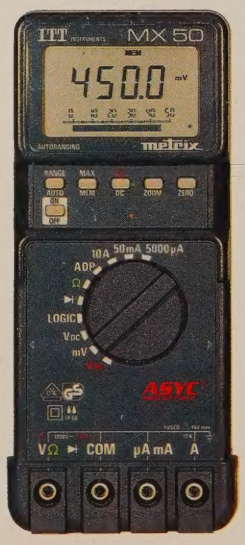

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